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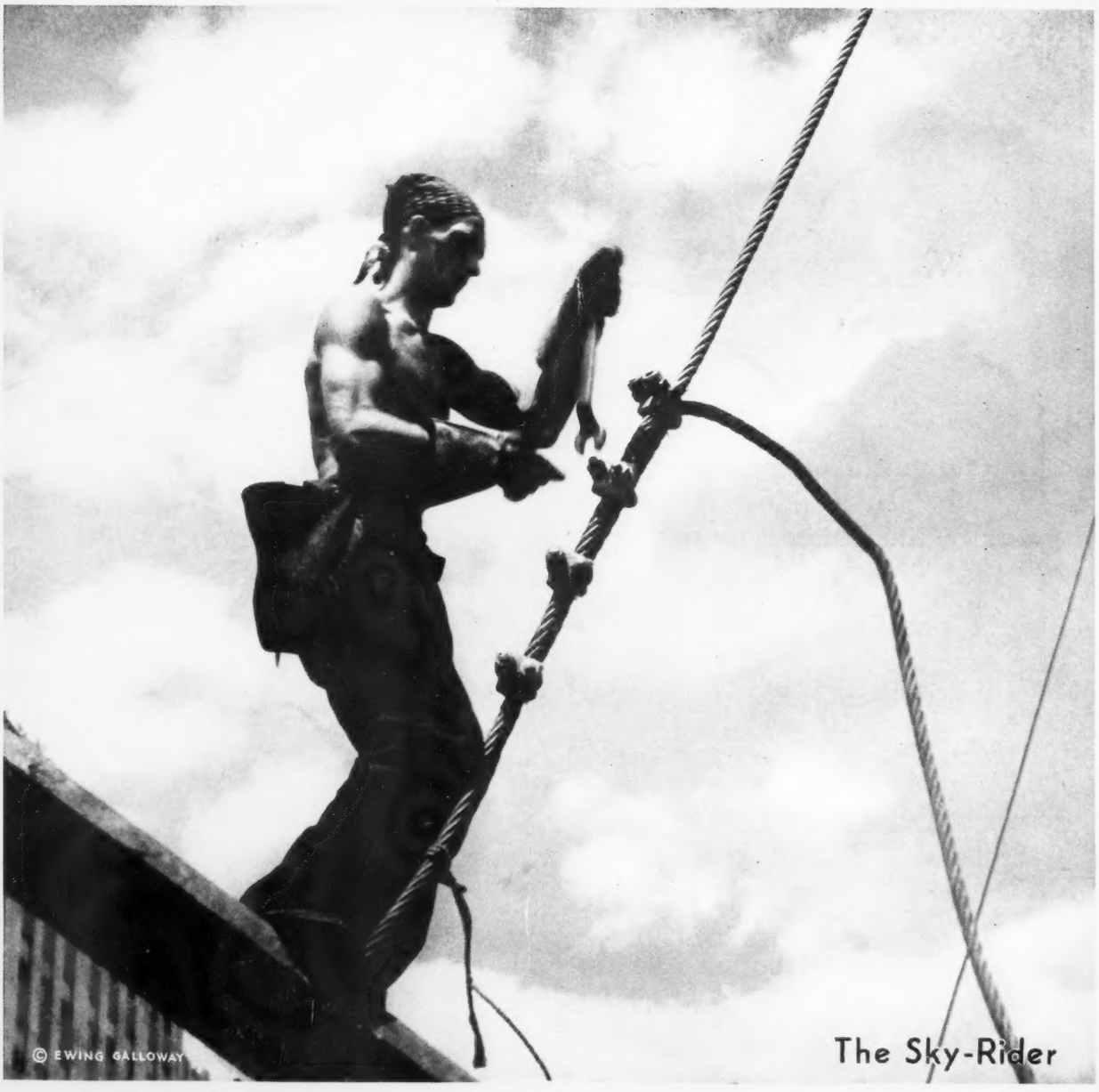
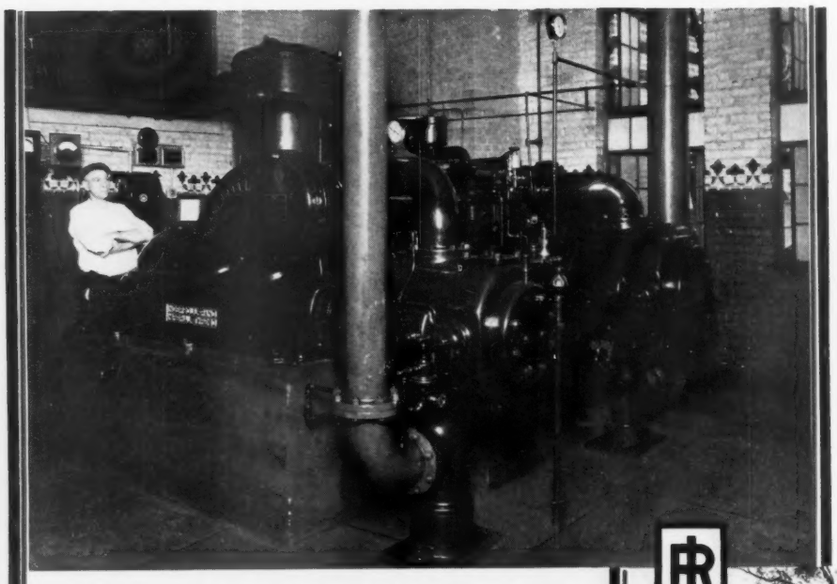


The Sky-Rider

This Compressor Helps Cleanse Clothes for 250,000 People



The I-R compressor which supplies air for many operations at the Little Falls Laundry.

THE Ingersoll-Rand compressor installation at the Little Falls Laundry, Little Falls, N. J., is believed by the owners to be the largest air plant in any laundry. It consists of a Type XRE synchronous-motor-driven unit with a piston displacement of 676 cu. ft. per min. In addition, there are two small units which were used before the installation of the larger unit.

Air is used to operate laundry presses, to maintain a suction in suit presses, to furnish air to the garages, and for general maintenance and cleaning work.

Ingersoll-Rand has a suitable compressor for economical and dependable service on most any application.

1051-C

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The home of the Little Falls Laundry.

Air-operated presses for wearing apparel.

As It Seems To Us

WHAT ARKWRIGHT STARTED

RICHARD ARKWRIGHT, a Lancashire barber who showed the world how the production of cotton goods could be increased sixfold, was born 200 years ago last month. ARKWRIGHT is credited with certain inventions which enormously increased the rate of spinning yarn—a need for which had arisen through the creation of KAY's flying shuttle which doubled the rate of weaving with a hand loom. It is now pretty definitely established that ARKWRIGHT did not actually originate the machinery: he merely capitalized the genius of others. There can be no doubt, though, that ARKWRIGHT first applied factory methods to the manufacture of fabrics, and transformed industry from a thing of individualism to one of collectivism. It is significant that WATT received a patent on his steam engine in the same year that ARKWRIGHT obtained his patent. These two men revolutionized methods of making things.

The people revolted against ARKWRIGHT's progressivism. He dared not initiate his new methods in his own Lancashire, so he established his first factories in Nottingham. Later, when he did venture to set up a mill in his home section, the mob burned it. That was the beginning of the attack upon mechanization—an assault that we are hearing much of now. The best brains of the universe are a little uncertain in these times just where technological progress is leading us. There can be no doubt, however, that the sum total of human happiness and comfort is enormously greater than it was 200 years ago. On the other hand, there is much want and suffering today wherever mankind dwells. Conservative thought leads inevitably to the conclusion that something is askew. It is evident that we have not adapted ourselves to the machine age, that things are out of balance, and that civilization must find some sort of economic stabilizer to offset the violent waves that periodically threaten to founder the ship of well-being.

The solution will not be found in a day or in a week. That it will be found eventually is indicated by the fact that sound-minded men are earnestly applying themselves to the problems. Certain it is that we cannot progress by retrogressing. To lay our burdens to the machine is to confess our inability to work out our own salvation on a basis of modernity. Common sense dictates that we must keep the advances we have made in the direction of producing things, and bring other portions of our economic system up to the same level of efficiency. The locomotive that pulls civilization along has perhaps shown such power as to break loose from the train, but that is no reason for junking the engine. We have got to improve the cars and their couplings so that they will ride along with the locomotive at the faster pace.

RESEARCH—MASTER SALESMAN

IN THE face of a 19-per cent decrease in world consumption of nickel during the first nine months of 1932, four alloys of nickel had a wider usage than in 1931. This resulted from researches which revealed the adaptability of these alloys to a diversity of services. Thus does scientific investigation pay its way. Two of these alloys were nickel cast iron, another was nickel-coated steel plate, and the fourth was a chrome-nickel compound.

A few years ago coinage and nickel-plating constituted practically the sole outlets for nickel. Today, they consume less than 10 per cent of the production, although these older uses have consistently increased. We are told that nickel-clad steel is becoming more and more important for storing, processing, and transporting in those industries which have to handle corrosive chemicals, or in which liquids must be protected against contamination from containers. Barrels are now being made of this material, and they promise to replace wood in some fields.

Nickel is coming into greater use as a catalyst. Monel metal, which contains 67 per cent nickel, is continually widening its service in both industry and the home, and is being utilized for such divergent purposes as cans for seafood and identification tags for laundries. Dairy equipment is being made from Inco chrome-nickel, which contains 80 per cent nickel. Nickel-brass and nickel-bronze are important now; and heat-resistant nickel alloys are replacing refractories in furnace construction and are also entering into home electrical appliances. Nickel-steel is of great utility in the automotive and railroad industries, and can now be nitrided. One railroad line has built a coach largely from nickel-bearing stainless steel. Ni-Hard, a wear-resisting cast iron, grew measurably in use during the past year, and more than 1,000 tons of it went into rolls alone. Among the new alloys developed is a nickel wrought iron which is reported to add from 25 to 50 per cent to its strength.

These and other nickel products have been developed in the laboratory. Without the ministrations of research, nickel would still be a comparatively unimportant metal. There is no salesman on the staff of The International Nickel Company that can even approach the effectiveness of the concern's scientific investigators.

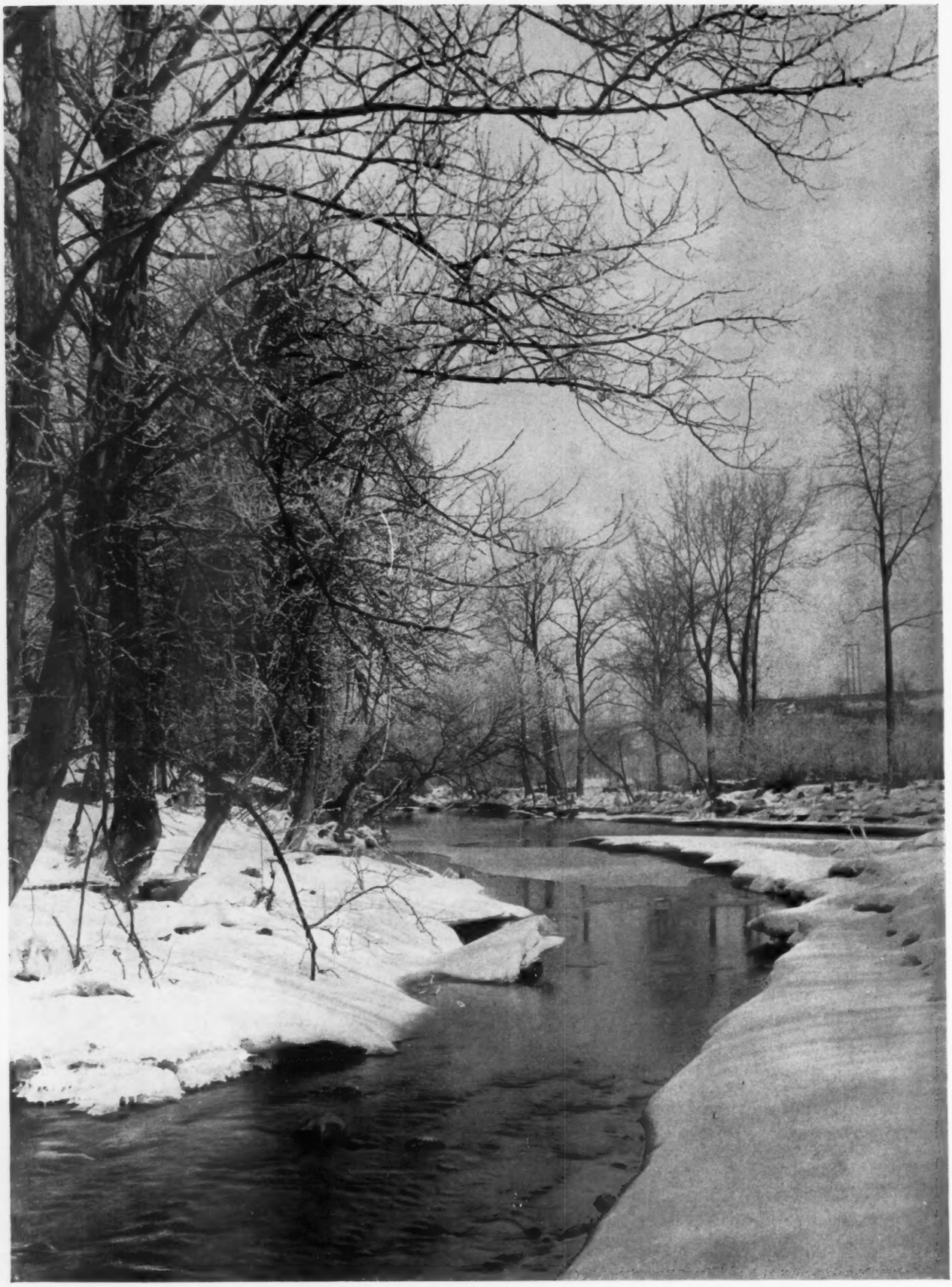
THE LION AND THE LAMB

A FEW years ago, when industry was riding the crest of the golden wave, there was a tendency on its part to discount the gravity of the problems that bedeviled it and to bowl along at full speed, trusting that cross traffic would get out of the way. Now that the juggernaut has slowed down to a snail's pace, it is easier to see the obstacles in the road. They loom up larger and constitute a more menacing peril to a safe journey. As a result, they are given saner and a more sober consideration.

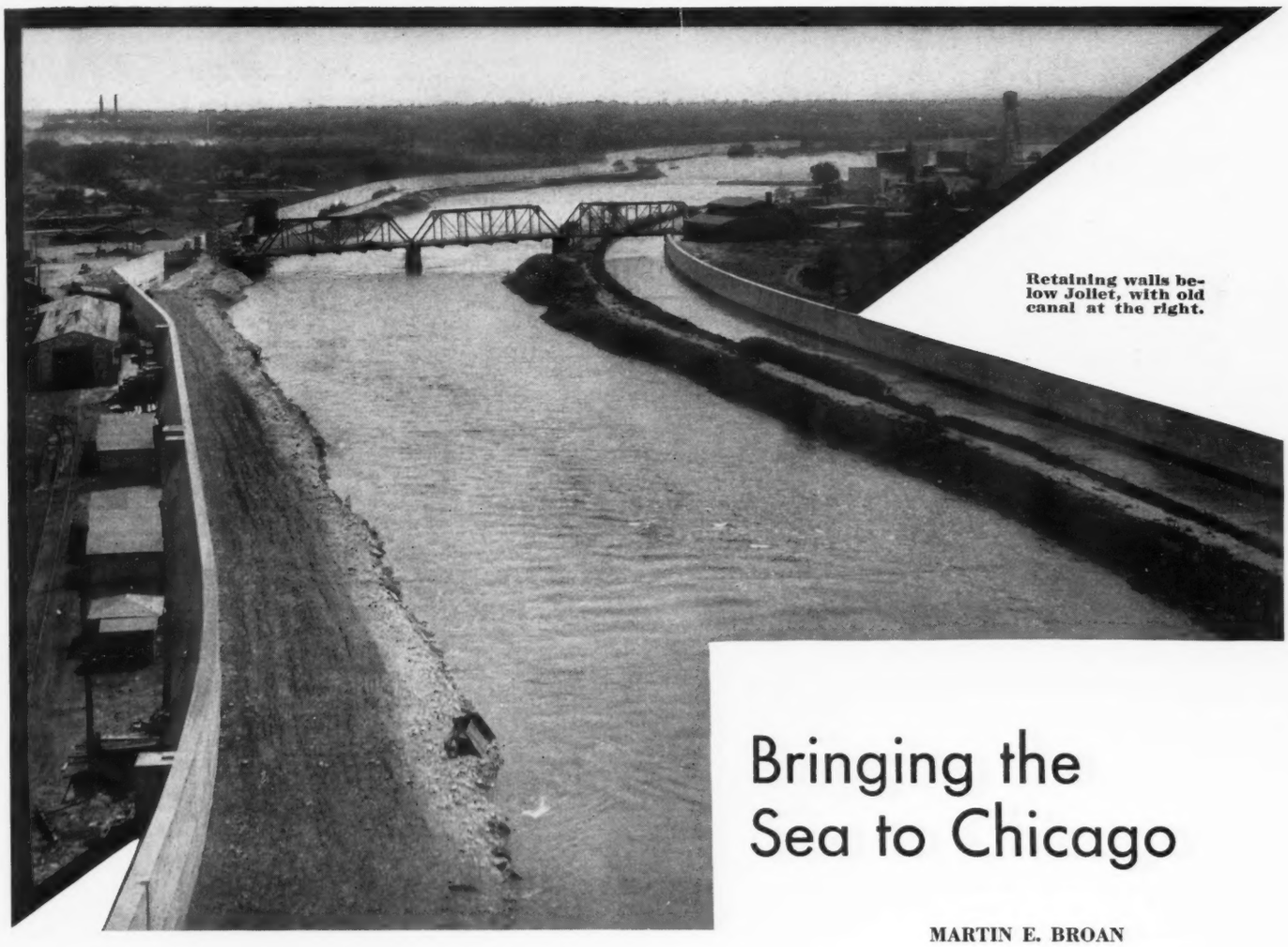
An example in point is the changed attitude of railroads towards automotive transportation agencies. When buses and trucks first ventured upon the highways as common carriers there were few railroadmen who would admit that they were there. Those who did admit their presence apparently thought that their existence would be short-lived—that they could never attain the status of serious competitors. It turned out that the railroads guessed wrong. Trucks and buses grew increasingly stronger, and the ironical part of it was that they did so largely because fine highways were provided for them from taxes to which the railroads were heavy contributors. Obviously, this was unfair; but the service rendered by automotive equipment was of such public interest and convenience as to over-ride objections.

Now, however, the railroads have swallowed their bitter dose, admitted that there are some advantages in these new modes of transportation, and are showing a tendency to coördinate rail service with them. Significant is a recent statement by Pres. W. W. ATTERBURY of the Pennsylvania Railroad, undeniably one of the most capable of railroad executives. General ATTERBURY agrees that charges for hauling passengers and freight must be reduced, and declares that he is not championing regulation of competitive systems that will permit perpetuation of existing rail rates. Rather is he seizing the opportunity of improving rail service through coöperation with road carriers. He reports that the Pennsylvania is already taking a financial interest in bus lines and that it is finding them profitable. The railroad is also using trucks on short hauls and moving freight from shipper to receiver without rehandling.

"Motor transportation is best adapted for short hauls, railroad transportation for long hauls," he states. "We can carry the loaded truck body from city to city by rail for much less than it costs the trucks to move it over the highway. If the railroads act intelligently they will give to the motor industry their terminal deliveries, and the motor industry will find it the part of intelligence to give to the railroads the long hauls in turn."



J. C. Allen—Ewing Galloway



Retaining walls below Joliet, with old canal at the right.

Bringing the Sea to Chicago

MARTIN E. BROAN

Pere Marquette's Dream of a Waterway to the Gulf is Coming True

THE EARLY summer of 1933 will bring to a realization an idea suggested 259 years ago by an early explorer of the wilds of North America. In 1674 Pere Marquette wrote in a letter to France of a trip he and Louis Joliet, his partner and friend, had taken through what is now the State of Illinois. These two adventurers paddled up the Illinois and Des Plaines rivers, carried their canoes across the Chicago portage, lowered them into old Mud Lake, and descended to Lake Michigan. Marquette suggested that here was an ideal place for a cut or canal to connect what he called the "Lake of the Illinois" and the river he knew as the "St. Louis." In his estimation, the advantage of being able to build a boat on Lake Erie and sail it to the Gulf of Mexico could not be overrated.

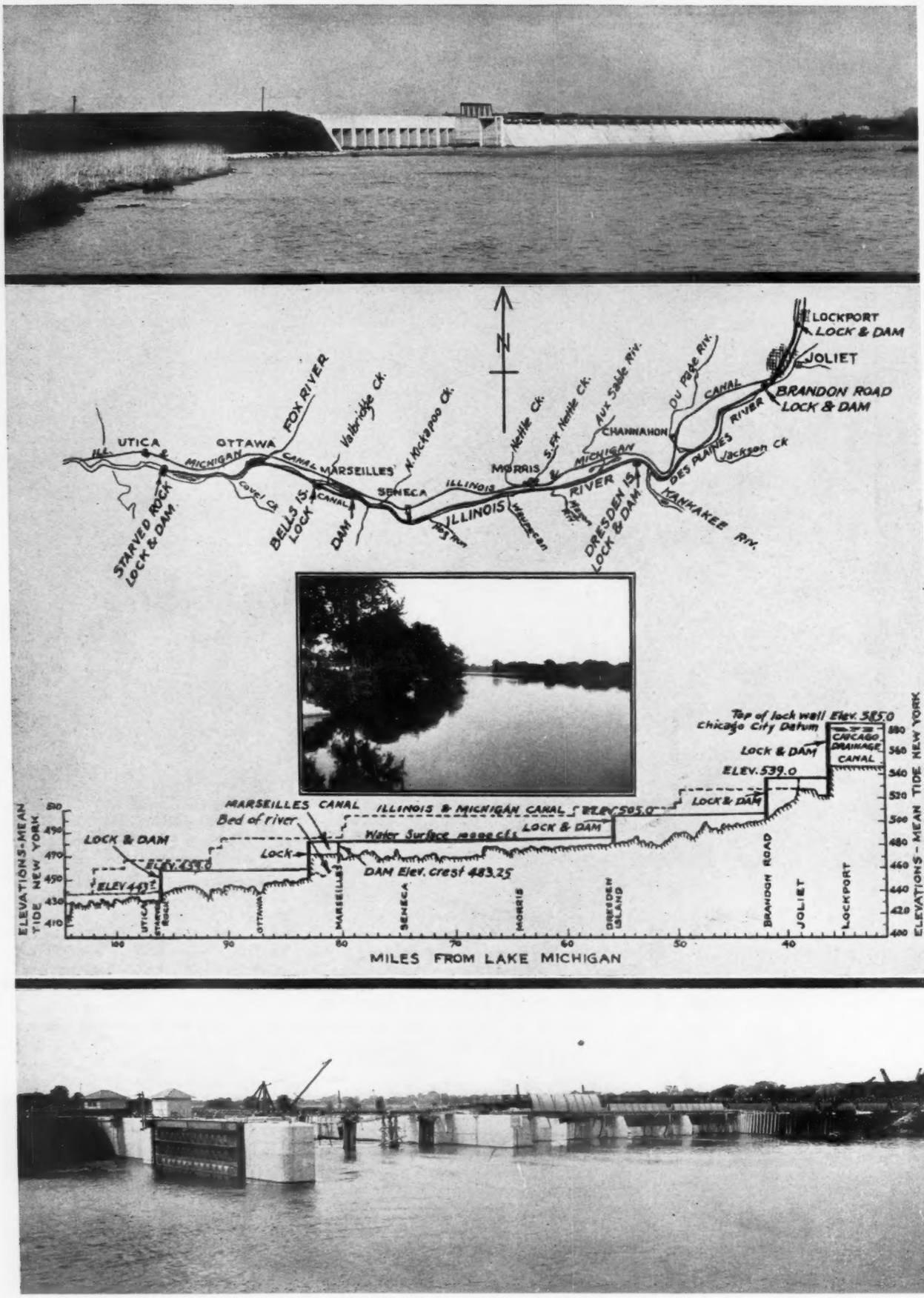
Many others have considered the advantage of making Chicago a seaport; and now the old priest's dream is to come true. The summer of 1933 will be a fitting time in which to inaugurate service on the Illinois Waterway, as it will mark the hundredth anniversary of the incorporation of Chicago as a town, an event to be commemorated by Chicago's second World's Fair.

The undertaking, although dwarfed by the Hoover Dam, is of considerable size and of vast importance. It will make a seaport of Chicago, second largest city in the United States and the greatest railroad terminus in the world; it will open the Great Lakes to the Gulf of Mexico; and, from a financial point of view, it will bring the central and mid-western states closer to the Pacific Coast.

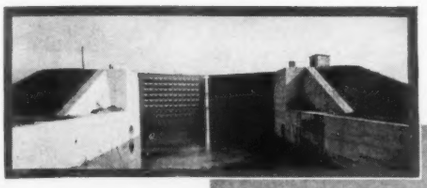
In order to connect the waterway system of Chicago with that of the Mississippi it was necessary to improve the Illinois and Des Plaines rivers between Lockport and Utica, a distance of about 65 miles. The Chicago River, together with the Chicago Drainage Canal, is navigable as far as Lockport, and the Illinois is used for transporting freight from Utica to Grafton, Ill., where it flows into the Mississippi River. At points throughout this 65-mile unnavigable stretch there were very shallow places and rapids, and the presence of several privately owned power dams caused an erratic flow. In addition, the rivers dropped so fast as to necessitate the building of five locks and four dams to make them at all passable to boats of the size planned for use on the system.

Although it had been long proposed, and $20,000,000 in bonds had been authorized for the purpose in 1908, it was not until 1919 that the State of Illinois took definite steps toward actual commencement of the development. Work was begun in 1920 and carried on by the state until 1930, when all available funds, except $4,000,000 set aside for the building of bridges, were exhausted. Failure of the appropriation to complete the project was due largely to the considerable advance in the cost of labor and materials during the years that intervened from the time the bonds were voted. Work was necessarily halted, and an appeal was made to the Federal Government for additional money to finish the undertaking. In February, 1931, the sum of $7,500,000 was appropriated for the completion of the system under Federal supervision. All contracts then in effect were cancelled and new ones were made.

Thus, the development is a dual enterprise, and, when finished, will have cost approximately $27,500,000. It will provide a channel of 9 feet minimum depth for barges and shallow-draft boats. Upon completion, the work will have involved the acquisition of some 6,000 acres of land, the excavating of approximately 4,000,000 cubic yards of earth and rock, the placing of 750,000 cubic yards of



The view at the top shows the Brandon Road Dam. In the center is a glimpse of the Marseilles Pool and at the bottom is the Dresden Island Lock and Dam. The upper sketch shows the locations of the principal improvements and the lower one indicates the differences in elevation that had to be overcome.



Lower lock gate, Brandon Road Lock.

Right—Constructing retaining wall, Brandon Road Lock.

concrete, and the use of 10,000 tons of steel and iron.

The undertaking is now in its final stages. All the locks are finished and the last dam is nearly in place; lock-gate operating machinery is being installed; lock-keepers' houses are being built; new, movable bridges are being constructed by the state; a pilot cut, 100 feet wide, through all the pools is assured by spring; and landscaping of the immediately surrounding areas has been started. Everything will be in readiness by early summer, when barges will ply their way through Illinois to the Mississippi River, and thence to the Gulf of Mexico—and Chicago will be truly a seaport.

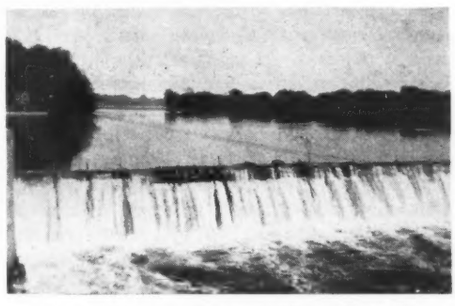
The following table, which was supplied by the United States Engineers, lists the various items of construction and their approximate costs:

	Cost
Starved Rock Lock and Dam	$3,237,000
Marseilles Lock	1,773,000
Marseilles Canal	937,000
Marseilles Dam	456,000
Dresden Island Lock and Dam	2,365,000
Brandon Road Lock and Dam	3,512,000
Brandon Road Pool	3,247,000
Lockport Lock	1,973,000
Channel improvement	2,374,000
Bridges	4,000,000
Rights of way	3,437,000
Miscellaneous	189,000
Total	$27,500,000

Because the work was spread out over so great a stretch, conducted over a period of considerable duration, and directed by two governmental agencies, it involved a large number of individual contracts. It would be impossible to describe the activities in detail in a short article, and it is our purpose here merely to present the important features of specific parts of the undertaking.

It was decided to begin operations with the building of the Marseilles Lock, and this was designated as Contract No. 1. Bids by five contractors were opened on October 18, 1920, and the award was made to Greene & Sons Company, of Chicago, Ill., who began work soon afterwards. The Marseilles Lock is one of five locks placed in the Illinois River and its tributaries between Lockport and Utica. These locks have chambers 110 feet wide and 600 feet long, with a total length, including approach walls, of 925 feet and a depth of 14 feet on the miter sills. These dimensions give each chamber a capacity of 9,000 tons per lockage and of 9,000,000 tons per month. The chambers are fed by 12-foot circular culverts running lengthwise through the lock walls. Through these, water flows into and out of the lock chamber by way of small lateral openings that are designed so as to eliminate the possibility of surge under the barges. Four valves, each weighing 4½ tons, control the flow through these weirs.

Owing to the fact that the lock site was some two miles west of the Town of Marseilles, it was necessary to provide quarters for the workers. Hence, early in November, 1920, carpenters went to the scene to erect housing facilities and field offices. This was the first construction on the waterway system. The first excavation was made soon after by the New Era Construction Company, of Chicago, under a subcontract. A total of 263,000 cubic yards of earth, shale, and rock was excavated and wasted. Much of the drilling was done with Ingersoll-Rand BCR-430 "Jackhamers", which proved very satisfactory on this kind of work and made rapid progress through shale and rock. The building of the lock, together with the upper and lower 600-foot approach walls, required the pouring of 63,100 cubic yards of concrete. The lock was finished and accepted by the state in August, 1923. The miter gates have since been put in place, the operating machinery installed, and the lock tested.

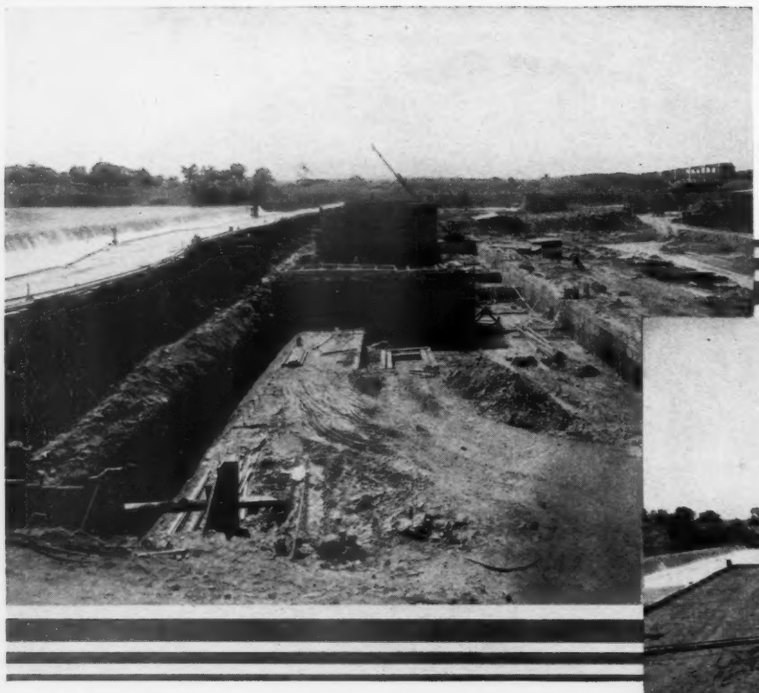


The old power dam at Marseilles, Ill.

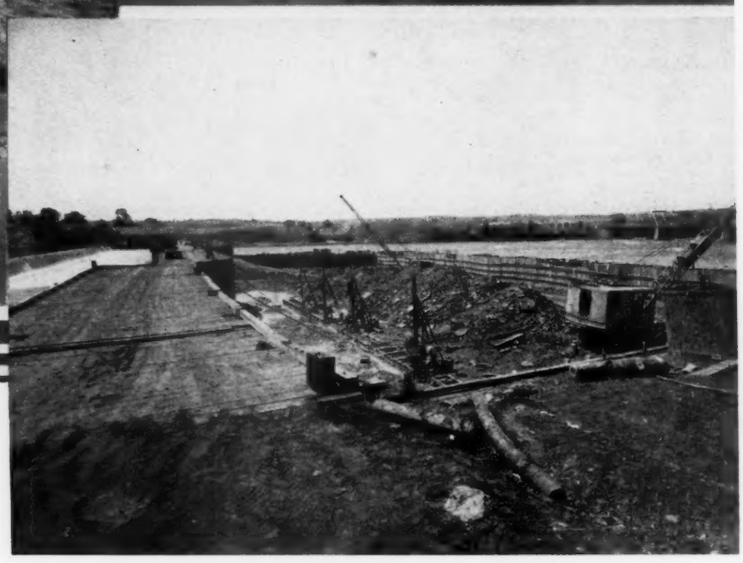
Soon after work had been begun on the Marseilles Lock, bids were asked for the construction of the Starved Rock Lock and Dam between Ottawa and Utica. Only two contractors entered bids, and these were so excessively high that both were rejected. Their reason for the high bids was that the possibility of loss from floods was too ominous. Finally, in February, 1926, a contract was awarded to the Woods Brothers Corporation, of Lincoln, Neb., with an agreement whereby the state was to compensate the contractor for losses entailed by flood waters.

Construction was started soon after the contract had been secured. Cofferdams were built and pumped out, and excavating was begun. In all, 482,000 cubic yards of rock and dirt was removed and 112,600 cubic yards of concrete poured. As predicted and feared, high floods caused considerable damage and much loss of time, but the work was completed, accepted by the state, and by April, 1930, was ready for the miter gates.

The standard lock at Starved Rock has a lift of 16 feet, with a chamber that may be filled or emptied in 7¼ minutes. A headgate structure for a possible power house was also built, and the dam fitted with a 30-foot ice chute and ten Taintor gates. These gates are 60 feet long and are designed to withstand a head of 19 feet. With counterweights, they weigh 200 tons each, and, at the time, were



Constructing piers for the Taintor gates, Marseilles Dam.



Drilling and broaching with Class D wagon drills at the Marseilles Dam site.

the largest ever constructed.

In the Illinois River at Marseilles there is a privately owned power dam below which are rapids. To prepare the way for navigation without disturbing the structure or interfering with the generation of power, the engineers decided to build a new dam, 120 feet downstream from the old one, and to cut a canal extending downstream from just above it to the Marseilles Lock. The canal was dug in the flats along the west bank of the stream. It is 2½ miles long and 200 feet wide at the bottom. For about two-thirds of its length toward the lock the canal is formed of a spoil bank on the river side. The other side of the cut is quite low in places, and a considerable area will be flooded when water is turned into the system. Excavating was for the most part done entirely below the original ground level. Actual work on the cut was begun soon after the contract was awarded to the W. E. Callahan Construction Company, of St. Louis, Mo., in July, 1929, and continued up to January, 1930, when a short shutdown was caused by inclement weather. Except for about 80,000 cubic yards of material at the upper end, that was to be removed by the builder of the Marseilles Dam, the canal was completed by July, 1930. A total of 745,849 cubic yards of rock and 418,494 cubic yards of dirt was excavated. Ingersoll-Rand R-39 "Jackhamer" drills were used exclusively on the rock work. It is in the section left by the canal contractor that the 700-foot approach walls to the canal are being constructed.

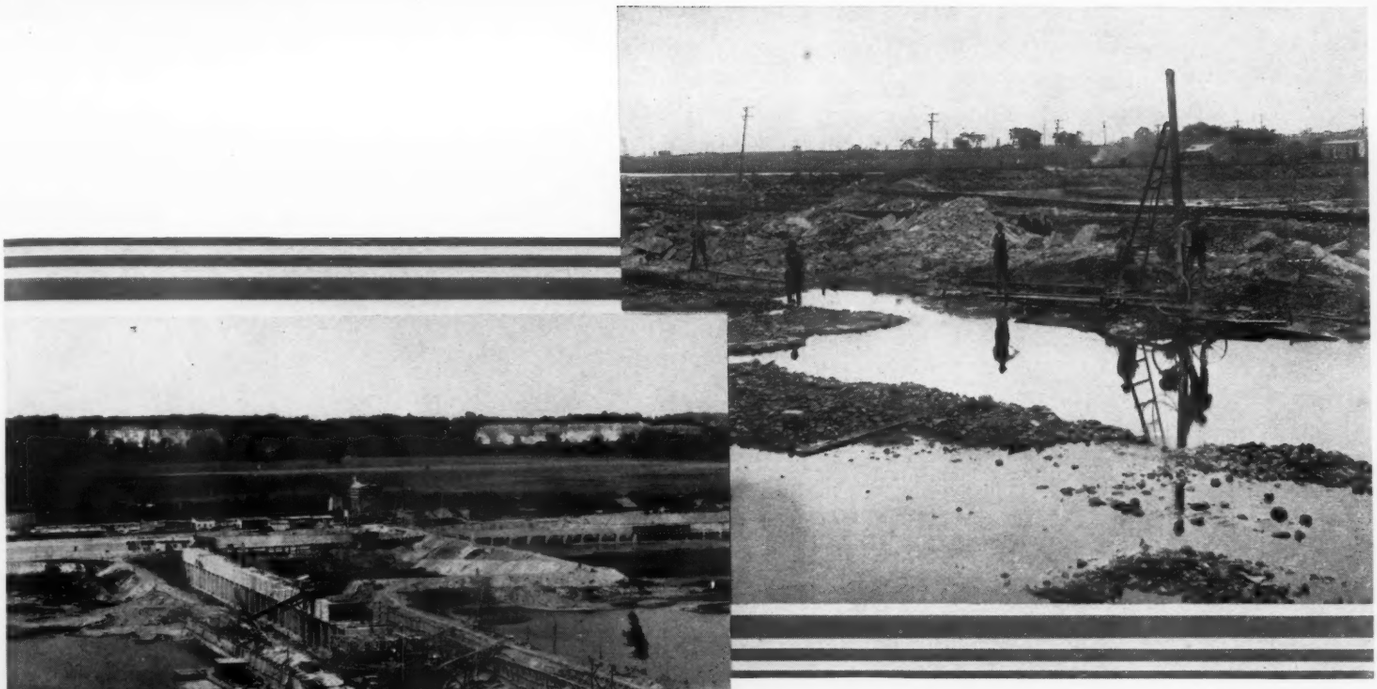
In the spring of 1932, The R. C. Huffman Construction Company of Cleveland, Ohio, rather than carry equipment overland to work on a contract in the Marseilles Pool, made a cut down to grade about 60 feet wide through the remaining section of the canal and floated equipment through the Marseilles Lock and up the canal into the river above the dam. This cut was closed again immediately and the canal drained.

The completion of the Marseilles Canal and the building of its approach walls are included in the contract for the Marseilles Dam, which is held by Stevens Bros. & The Miller-Hutchinson Company of New Orleans, La. Work on these portions of the job was begun early in 1932 and is now nearly finished—the remainder of the canal is being excavated, the approach walls are in process of construction, and the dam is being fitted with Taintor gates. The old dam will be removed as soon as the new dam is completed and in operation. In addition to the eight Taintor gates, each of 60-foot span, and the 30-foot ice chute that go to make up the dam, the contractor for the structural steel is placing three 60-foot Taintor gates in the power-plant head races to control the flow.

Practically all the material removed, both in the construction of the dam and in the completion of the canal, has been rock, and its excavating has called for a compressor plant of considerable size. Two Ingersoll-Rand stationary units—a 14-inch Type XB-2 and a 12-inch Type XCB---were installed. A 10x8 Type 20 portable compressor was provided chiefly for use on the canal. Four Ingersoll-Rand X-71 Class D wagon drills, skid mounted, have been employed to do the drilling. The modern field blacksmith shop contains a No. 50 drill sharpener, a No. 26 oil furnace, and a 4K grinder. The rapidity of progress at this point will assure the operation of this part of the project long before the system is open to navigation.

In December, 1928, the State of Illinois came to an agreement with the Congress Construction Company, of Chicago, whereby that company was to build a lock and dam at Dresden Island, about a mile below the point where the Kankakee and Des Plaines rivers converge to form the Illinois. The work was to be done by the contractor on a cost-plus sliding-fee basis, the state to furnish all equipment and material. During the course of construction, the state ran out of funds, and completion of this particular phase of the project was undertaken by the United States Government. As soon as the United States Engineers assumed charge, all contracts with the state, except some few that were well underway, were cancelled and public bidding for the remaining work was invited. The Dresden Island Lock and Dam was one of the jobs open to rebidding. The Congress Construction Company secured the contract and immediately resumed operations, continuing thus until the conclusion of the work in October, 1932.

The lock at this point is of the standard,



Wagon drill working on the site of the Dresden Island Pool.

A view of the Starved Rock Lock and Dam at the height of activities.

miter-gate type used throughout the waterway, and has a lift of 17 feet. Provision has been made for the building of an auxiliary lock, should it be deemed necessary in the future. The earth-embankment dam has concrete retaining walls; head gates for a possible power house; nine Taintor gates, of 60-foot span each, with piers; an ogee spillway dam; and a 30-foot ice chute. The gates on this lock are of the mitering type—the upper ones are 20 feet high and the lower ones 37 feet high.

The rock drilling on this job was done mainly with the aid of twelve Ingersoll-Rand S-49 "Jackhamers" supplied with air by a 14x12 Class ER compressor and two 10x8 Type 20 portables. A No. 50 sharpener and a No. 26 oil furnace made up the drill-steel-maintenance equipment in the field blacksmith shop. This contract has been completed.

Another large construction job underway at the time the Federal Government assumed responsibility was the Brandon Road Lock and Dam, near Joliet, Ill. This work, like that at Dresden Island, was being done on a cost-plus basis, and the contractor was Greene & Sons Company. This agreement was annulled and a contract awarded to the Connely Construction Company, of St. Paul, Minn., which also has finished its work.

The Brandon Road standard lock has a lift of 31 feet; the upper lock gates are 20 feet high; and the lower gates 50 feet high. The dam includes retaining walls 2,000 feet long; an ice chute of 30-foot span; head-gate structures 500 feet in length for possible power-house use; six sluice gates with openings of 6x8 feet; and an ogee spillway dam, 1,350 feet long and 40 feet high, with 21 movable Taintor gates set on piers erected 50 feet apart on top of the ogee spillway dam. These gates will regulate the pool level above the dam. Bridges, 22 feet wide and 50 feet long, were built over the ice chute and the Taintor gates.

In October, 1923, the State of Illinois awarded a contract to Greene & Sons Company for the construction of the largest lock chamber of the system and one of the highest lift locks in existence. This lock is near Lockport, at the head of the stretch of waterway under improvement. It directly connects the Chicago Sanitary and Ship Canal with the Des Plaines River. Operations on the structure began soon after the contract had been awarded, and it was completed in December, 1927. A total of 171,000 cubic yards of earth and rock was excavated. The rock was drilled with Ingersoll-Rand X-70 drifters, mounted on quarry bars, and with DCR-23 "Jackhamers." Air for these drills and for various other air-operated units was supplied by an Ingersoll-Rand 16-inch Type XCB compressor and by two 9x8 Type 20 portables. A No. 50 sharpener was used for reconditioning drill steels. This equipment was also utilized at the lock and dam at Brandon Road and for the construction of a part of the retaining walls at Joliet.

An unusual feature of this 41-foot lift lock is the upper lock gates. While all other lock gates throughout the system are of the mitering type, these particular gates are of the vertical-lift type. They are 20 feet high and each weighs 190 tons. Large counterweights aid in their operation. The lower gates are of the standard mitering type and consist of two leaves, 60 feet high, each weighing 315 tons. A 50-ton emergency dam, hydraulically operated, is located in the floor of the upper gate chamber; and a shutter dam, of 75 tons, is built into the floor of the lower gate chamber. These gates are for emergency use in case of damage to the regular gates. The lock chamber can be filled or emptied in twelve minutes.

In addition to the building of locks, dams, and canals to make the waterway available to traffic, it was also necessary to carry out an extensive channel-deepening program throughout the entire 65-mile stretch. To that end, contracts were issued by the United States Engineers covering the removal of 2,664,000 cubic yards of earth and 606,000 cubic yards of rock in the Starved Rock, Marseilles, and Dresden Island pools and in the vicinity of the Lockport Lock. The State of Illinois had previously removed 414,000 cubic yards of earth, making a grand total of 3,684,000 cubic yards of material to be excavated from the pools above the locks to provide a 9-foot channel for the passage of boats.

The Starved Rock Pool, 13½ miles long,

A general view of the Lockport Lock during construction.

is being deepened by dredging. The Clark Dredging Company of Miami, Fla., and Galveston, Tex., is the contractor there. The R. C. Huffman Construction Company is dredging the Marseilles Pool. Considerable rock has been encountered in this section and has required the use of a drill boat to break it up so that it could be handled by dredges. This drill boat is equipped with six Ingersoll-Rand R-72 drifter drills, five 10x8 Type 20 portable compressors, a No. 50 drill sharpener, and fourteen DU "Utility" air hoists.

The Arundel Corporation of Baltimore, Md., was awarded the contract for the excavating of the Dresden Island Pool. This pool is fourteen miles in length and extends from the Brandon Road Lock to the lock and dam at Dresden Island. A subcontract for the dredging of the lower part of the pool was given to the Twin City Barge & Gravel Company of Minneapolis, Minn., which is using a suction dredge. The Arundel Corporation has undertaken to excavate 6,000 feet of the channel directly below the Brandon Road Lock. This section is being worked dry, earth dikes being constructed to form cofferdams that are pumped out so that Ingersoll-Rand X-71 Class D wagon drills and X-59 "Jackhamers" may be employed. About 50 per cent of the work is in rock. A 4-cubic-yard Marion steam shovel and several smaller gasoline shovels are used to load the spoils into dump cars, which are drawn by steam locomotives to points of disposal along the river banks. A 14-inch Type XCB air compressor furnishes air to the drills, and a 16-inch Type NFV Cameron pump serves to remove water from the cofferdams.

The building of the Brandon Road Pool was included in the contract for the construction of the Brandon Road Lock and Dam. Concrete retaining walls extend upstream from the dam on both sides of the river. The east wall varies in height from 15 to 40 feet, and has a length of 2⅓ miles, while the 2½-mile wall on the west side of the river has a continuous height of 23 feet. The bases of these walls are hollow and are being used as sewers by the City of Joliet. At the lower end of the pool the water will be raised to a depth of 31 feet so as to form a turning basin that will be one-third mile wide. The state also drove a tunnel, 350 feet long, under the river at this point for water and gas mains and telephone and electric power cables. The retaining wall was continued through the City of Joliet during the fall of 1931 and the summer of 1932 by the Tully-Costello Company, of Chicago, and by Greene & Sons Company. The entire channel will have a minimum width of 200 feet and a depth of about 10 feet.

Starved Rock Lock and Dam.

DIESEL-ELECTRIC TRACTION ON THE INCREASE

DIESEL-electric traction is winning increasing recognition the world over, according to the following news item that appeared in a recent issue of the *Electric Railway, Bus and Tram Journal* of London:

"A revolutionary move in railway practice, which will eventually lead to the scrapping of steam locomotives in Denmark, is reported from Copenhagen. The Danish State Railway administration, according to advices received, has announced that all future locomotive requirements are to be met by diesel-engined units and that no further steam locomotives are to be ordered. It is added that the State Railways, which have employed oil-electric locomotives since 1927, have on order an additional eighteen locomotives and seven rail cars with an aggregate of 6,000 hp.

"The new Danish policy follows a trend that is becoming increasingly evident among the world's railway companies. Diesel-powered locomotives—the general adoption of which in Britain would, it has been estimated, save 25,000,000 of the 52,000,000 pounds sterling spent yearly on steam traction—are today in regular service in eighteen overseas countries. No less than 277 large diesel-electric locomotives are now being built for Russia. Siam has thirteen in use, and is operating the Bangkok-Singapore mail trains with this type of locomotive.

"Thorough trials of the oil-electric system are being made by the London & North Eastern Railway at Newcastle, where a 250-b. hp. motortrain, which can carry 60 people at a speed of 65 miles an hour, has been running for eighteen hours a day for five months at a total fuel and oil cost of less than three farthings—1.5 cents, per mile.

"As a result of successful trials during the past two years with high-powered diesel-electric trains, the board of the largest British-owned railway in South America, the Buenos Aires Great Southern, has declared in favor of the extension of the use of this system. Four giant locomotives, each having 1,700 diesel-engine hp., have been completed for that road at the Armstrong Whitworth locomotive works at Newcastle-on-Tyne and are now on their way to Argentina."

Lost Mines

Tales of Rich Finds That Have Eluded Rediscovery

R. C. ROWE

THE announcement that a party of adventurers is seeking the origin of certain gold samples that were supposedly found with the body of Jack Hornby, brings to the fore the glamorous and colorful subject of lost mines. It will be remembered that the bodies of Hornby and his two companions were discovered in a shack on the Thelon River some two years ago. They had starved to death, and had lost their bitter fight with the great Northland.

With the bodies in the shack were found some very spectacular specimens of gold quartz. That is one story. Another is that Hornby had displayed some very remarkable samples on one of the rare occasions when he returned to the fringes of civilization. Anyhow, there seems to be very conclusive evidence that the wandering Hornby had, at some time, come across very high-grade gold-bearing rock that intrigued his fancy sufficiently to make him break off specimens which he has left behind him with that tantalizing incompleteness of record that seems to be typical of men of his nature. "Will the veins from which Hornby broke his samples ever be found?" is a more than ordinarily interesting question. The answer probably is "yes, some day, but it will be by accident rather than design."

We have a number of incidents to guide us in the opinion thus formed. After all, the north country of Canada is wide and long and big, and there's a mort of land and rock there, and, in that great expanse, the spot which supplied those samples is very small. We have many centuries of observation to show us that lost mines are seldom relocated. There are some that say that the discoveries at Great Bear Lake are in the vicinity of Bruce's lost mine; but there is some doubt about that. In any case it does not affect the argument.

The story of Bruce's lost mine is interesting. Apparently, Bruce was grubstaked in 1913 for one of those forlorn hopes that have always caught the imagination of men. He proposed to go down the Mackenzie to the Bear River, from thence to Great Bear Lake, and continue around it up to the Barren Lands and over to the Coppermine. It was an ambitious project. He expected to find mineral; though what hunch made his "wandering hoof" itch to take that long arduous journey no one will ever know now. The men who grubstaked him are still alive, but he is dead.

Bruce made his trip. He sent down fragmentary messages by trappers and such like means of communication. He reached the Coppermine River and moved backward down Great Bear Lake, but his exact route is unknown. Naturally all this took time. The great war broke out, and Europe was aflame; but Bruce, slowly traveling the great distances of the North, had no more idea of what was happening than the man in the moon. During the latter part of 1916 he was picked up by a mounted policeman in the Great Slave country and brought out to Edmonton for conscription purposes. The story goes that he was very angry. He felt he was misjudged; and he had all the woodsman's fierce love of personal freedom. As a result he said very little about his journey; but he left some samples and a vague map before he was moved to Calgary, where he contracted pneumonia and died within a few days. Here we have, again, tantalizing incompleteness; and we shall probably never know whether the discoveries that are attracting so much attention at Great Bear Lake were stumbled on to by Bruce or whether, somewhere in that vast region, the outcrops from which he chipped his samples have yet to be refound.

"The north country is wide and long and big."

Remote places always have a lure; but we do not need to go so far to find many a story of lost mines. Somewhere, for instance, on the Madawaska River, there is a high-grade silver showing that was found by no less a person than an Ontario Land Surveyor in the "fifties" or "sixties" of the last century. He stopped at a little spring for a drink, when his attention was attracted by a peculiar vein of rock. He chipped off a fragment, and, upon his return home, had it assayed. It carried over 50 per cent silver! No one would expect a land surveyor to lose a mine; but in this particular case the surveyor was smitten with smallpox which left him blind, and he was unable to describe the spot clearly enough for anyone to find it.

"He broke off some of it with his rifle stock."

Many years later, in fact quite recently, two strangers arrived in the locality and started inquiring for a certain corner post. They were foolish enough to disclose the reason for their curiosity, with the perfectly natural result that a native son, who was shrewd, sent them to the wrong post. In the course of time the strangers became discouraged, and, being rather good fellows, divulged all they knew about the matter. Since then the native son in question has been starting out from the certain corner post and following the vague directions which were apparently left by the blinded surveyor—"go about three miles north, then over two lots and find a little meadow, about two acres long, with a spring at the foot of a great rock outcrop which is at least two-thirds silver." He hasn't found it yet.

This story can be paralleled by a hundred similar examples. We know of a well-known mining engineer who spends his holidays seeking for a silver vein in the Laurentians not so far from Montreal. In this case, the vein was discovered by a man who was hunting and who severely scratched his hand on leaf silver that was exposed on a bluff that he was climbing. The scratch made him look for the cause; and, noticing the metallic appearance of the material, he worried off a piece with his little ax, showing it later to our engineer friend. He, of course, immediately recognized native silver, and has been looking for it ever since. The description of the locality is fairly good; but it is not quite good enough.

There is the incident of the man somewhere north of Fasset, along the north shore of the Ottawa River and in the area which is now Lucerne-in-Quebec, who found a chunk of gold quartz while taking a drink at a creek. He knew what it was; marked the spot in his mind; but lost his way getting out of the woods. While he would recognize the spot if he should come near it, he does not recall clearly where it is. He has searched long and often since, but has not yet found it.

It has often been remarked that the lost-mine stories must be all bunk, because a woodsman could not lose his sense of direction so entirely. This, however, is quite wrong, as even the most experienced woodsman will become misty about a specific location at times. Some years ago, one of the finest woodsmen that the writer of this article has ever met, was sitting on a bluff over a little lake eating his lunch. The man in question was on a timber cruise, and he was in country that he knew well. While eating, he idly noticed that the surface of the bare rock on which he was sitting was characterized by very perfect crystals that stuck out here and there. The regularity of the crystal shapes intrigued our friend, who finally took his small ax and broke off one or two of the protrusions. He then observed from the fresh broken surfaces the very fine color of the rock. A month or two later he showed the specimens to an officer of the Geological Survey who happened to be in the district. That gentleman immediately identified them as amethyst. As he explained, the material was of no great commercial value; but, from the description given him, the crystal specimens were so perfect that they would prove valuable additions to the museum of the Department. He therefore asked our friend if he could guide someone from the Geological Survey to the spot. Naturally, our woodsman said he would. "Why, sure", he said, "I could walk as straight as an arrow to the very spot. Why, it's on the south side of a little pothole of a lake that lies between Twin Lakes and Little Trout Lake. Just couldn't miss it."

But the point is that he did miss it. He started out blithely enough in company with one of the Survey's men and found the lake but not the amethyst. A peculiar thing about the whole matter was that, when he did not come upon the deposit immediately, our woodsman's sense of pride in his own capa-

bilities was offended—he had been so very sure he could just walk to the spot, and he therefore stayed for nearly two weeks searching. But even with this extra effort those perfect amethyst crystals still remain undiscovered.

There are many similar cases, and a more than interesting one concerns a farmer of German descent who lived in country lying between the Gatineau and Lievre rivers. This old chap was out hunting deer one day in the autumn when he got far beyond his usual beat, and, according to his story, was passing down a shallow ravine filled with elm trees when he noticed that some of the limbs, which were bare of leaves by this time, were covered with a grayish substance that rather reminded him of wool. He examined it quite mystified; and later told friends that some of the threads were 3 inches long. While still cogitating upon this rather remarkable phenomenon, he saw that an exposed rock surface also presented a somewhat woolly appearance. Here he found the fibrous material in place in the rock; and, being an astute old gentleman, it did not take him a moment to realize that the scouring action of wind and rain loosened the fibers and that the gentle winds blowing down the shallow ravine, or else the howling winds of storms, deposited the threads upon the branches of the trees. Naturally, however, he did not know what the fibrous stuff was; but it so occupied his fancy that he broke off some of it with his rifle stock and took it home, where it kicked around his log cabin for years. We may be quite certain that he often told the story, and we may be equally sure that most of his friends put him down as a garrulous old liar.

Eventually, an officer of the Geological Survey wandered into the neighborhood and was shown the samples, which he immediately identified as asbestos. The fiber was good; and, while it was not 3 inches long, it was of sufficient length to be attractive in a commercial sense. The geologist was somewhat puzzled, because asbestos had no business to occur in that particular locality; but the old German's story was told so naturally that he believed it. He explained the nature of the rock to his German host, and detailed its value and possibilities. Naturally, the old gentleman was excited at the prospect of becoming a rich man, for, like all people under similar circumstances, the hundred and one things that can happen to a mineral deposit before it becomes a profitable venture did not enter his mind. Neither did it occur to him that he might not be able to find the spot where he had seen the fiber-covered trees. Yet, he never located it. It became an obsession with him, and he spent the remaining years of his life looking for what he considered to be a fortune, and which possibly was one. Finally he passed away without finding the fiber-covered trees that had become so indelibly fixed in his memory. Perhaps some freak of Nature had covered the outcrop, thus stopping the weathering and the deposition of the wind-blown asbestos, or the old gentleman may never again have struck the spot to which he chased a deer years before.

Every mining camp has its story of a lost mine, and there is no doubt that most of these tales have some basis in fact. Nevertheless, it seems as though the rediscovery of lost mines is almost invariably the result of the same element that led to their finding originally—namely, luck, rather than design. But the recognition of that fact will never stop men from searching for them, nor will it take away one single bit of the glamour that is linked with their name.

"He immediately recognized it as native silver."

Industrial Piping of Glass

JUST as Pyrex glassware is a source of delight to the housewife, so will Pyrex piping appeal to industry primarily because of its cleanliness and the visibility or ease of inspection that it offers. The product is the outcome of laboratory work at the Corning Glass Works, Corning, N. Y., which is now turning out glass pipes on a commercial scale in varying straight lengths and dimensions. Elbows, tees, Y's, U's, and socket pipes also are provided, as well as a special metal joint that permits linking up as many sections as may be desired. Apparently there is no limit to the number that can be thus tied together, as evidenced by the fact that as much as eighteen miles of Pyrex tubing is in use in one plant.

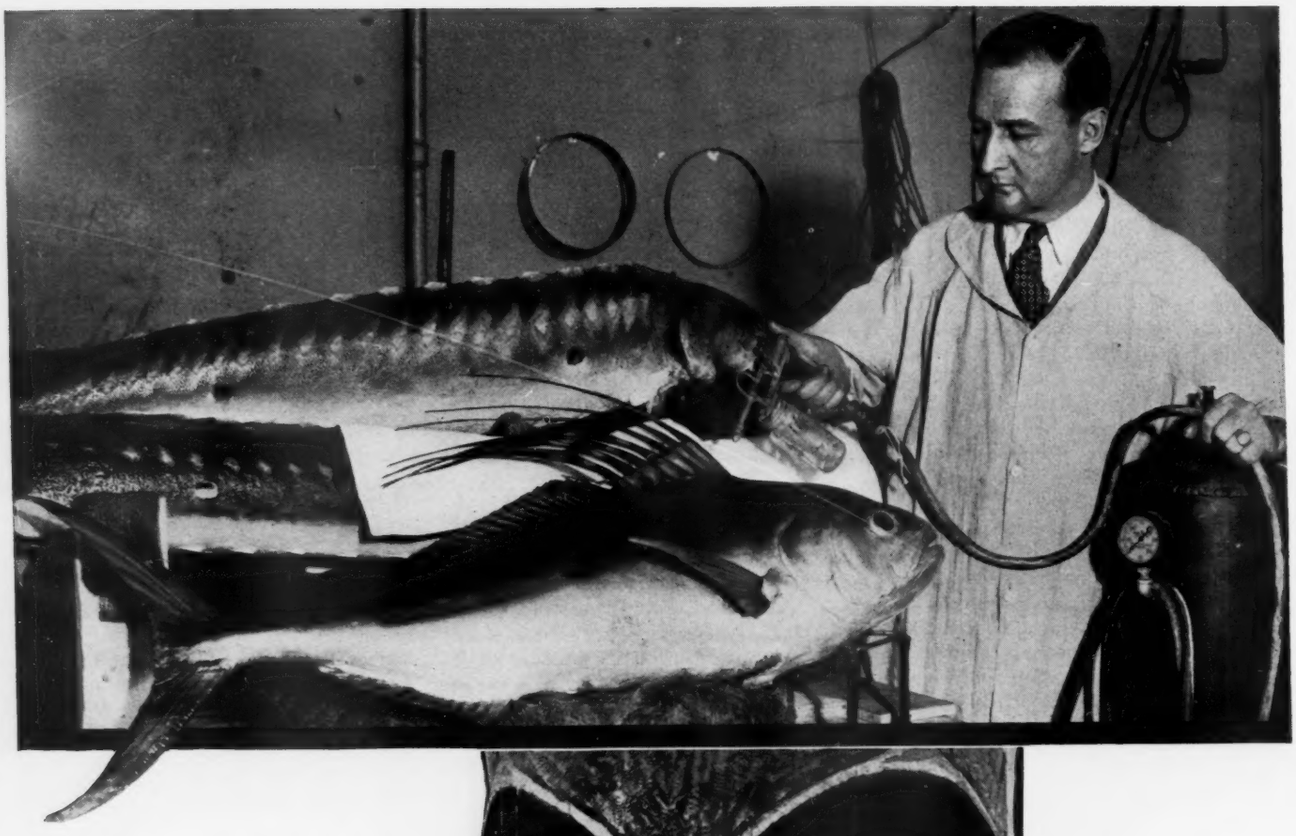
On first consideration, glass pipe lines would seem to be especially well suited for the transfer of beverages and semi-fluid foodstuffs, and so they are. But, because of the peculiar properties of Pyrex, it lends itself equally well to the making of pipes for the handling of gases and chemicals. In the case of the latter it is not a question of sanitation, but one of resistance. Apropos of this, we are told that such lines can withstand the corrosive action of all but hydrofluoric and glacial phosphoric acids; that they remain stable in the presence of alkalies; and that they can be subjected with safety to sudden and extreme changes in temperature. As a matter of fact, there is no danger of breakage even when extremely hot liquids are sent through them when the walls are cold.

Still other advantages claimed for the glass piping are: minimum resistance to flow and minimum contamination both inside and outside because of the almost diamond-hard smooth surfaces. For the selfsame reason there is little if any chance of a change in the quality of a fluid on its way through the line. When necessary, and this is easily determined, the system can be cleaned by flushing with steam or hot water—something that is of paramount importance in the handling of products for human consumption.

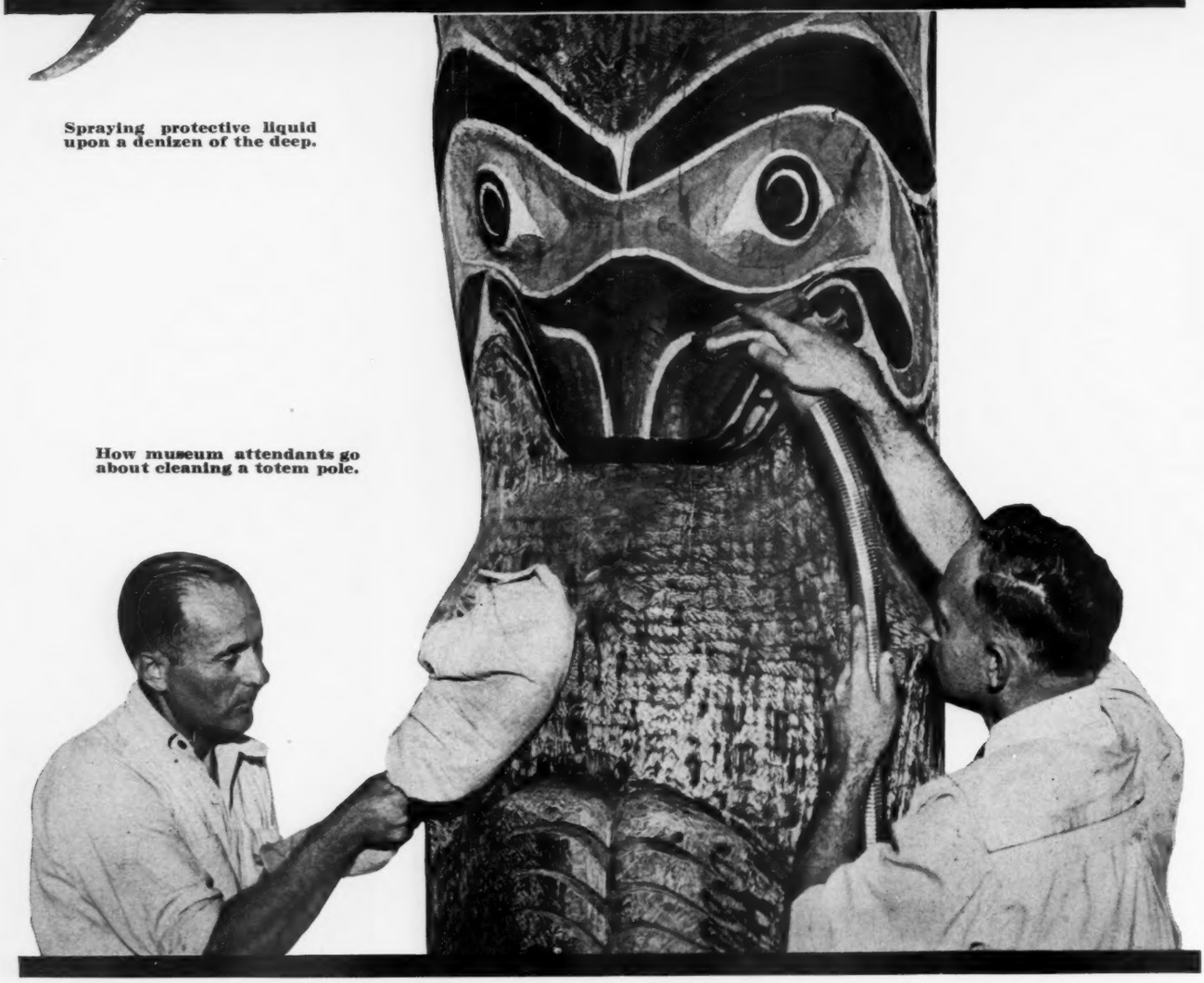
Inasmuch as Pyrex, itself, has been used for years in the manufacture of kitchen and tableware, the actual making of the pipe represented less of a problem than the joint needed to link up the separate lengths. The metal flanges that were finally developed are easy to apply by means of bolts and nuts, and are both leakproof and vaporproof under pressures up to 50 pounds—the maximum for which the standard glass tubing is designed. Special piping, however, can be supplied for pressure requirements in excess of 50 pounds. Effective packing is assured by a unique type of flange-faced gasket that centers itself perfectly. This is made either of asbestos or of a paraffin-impregnated paper, depending upon whether strong acids or milk, fruit juices, and the like, are being handled.

With glass piping there is no working in the dark. At any point along the system it is possible to watch the behavior of the contents—the rate of flow, the color, the viscosity, and the amount of sediment deposited. In short, a glass pipe line is a test tube on a magnified scale.

Testing process liquid and observing its flow through a glass pipe line as installed in an industrial plant.



Spraying protective liquid upon a denizen of the deep.

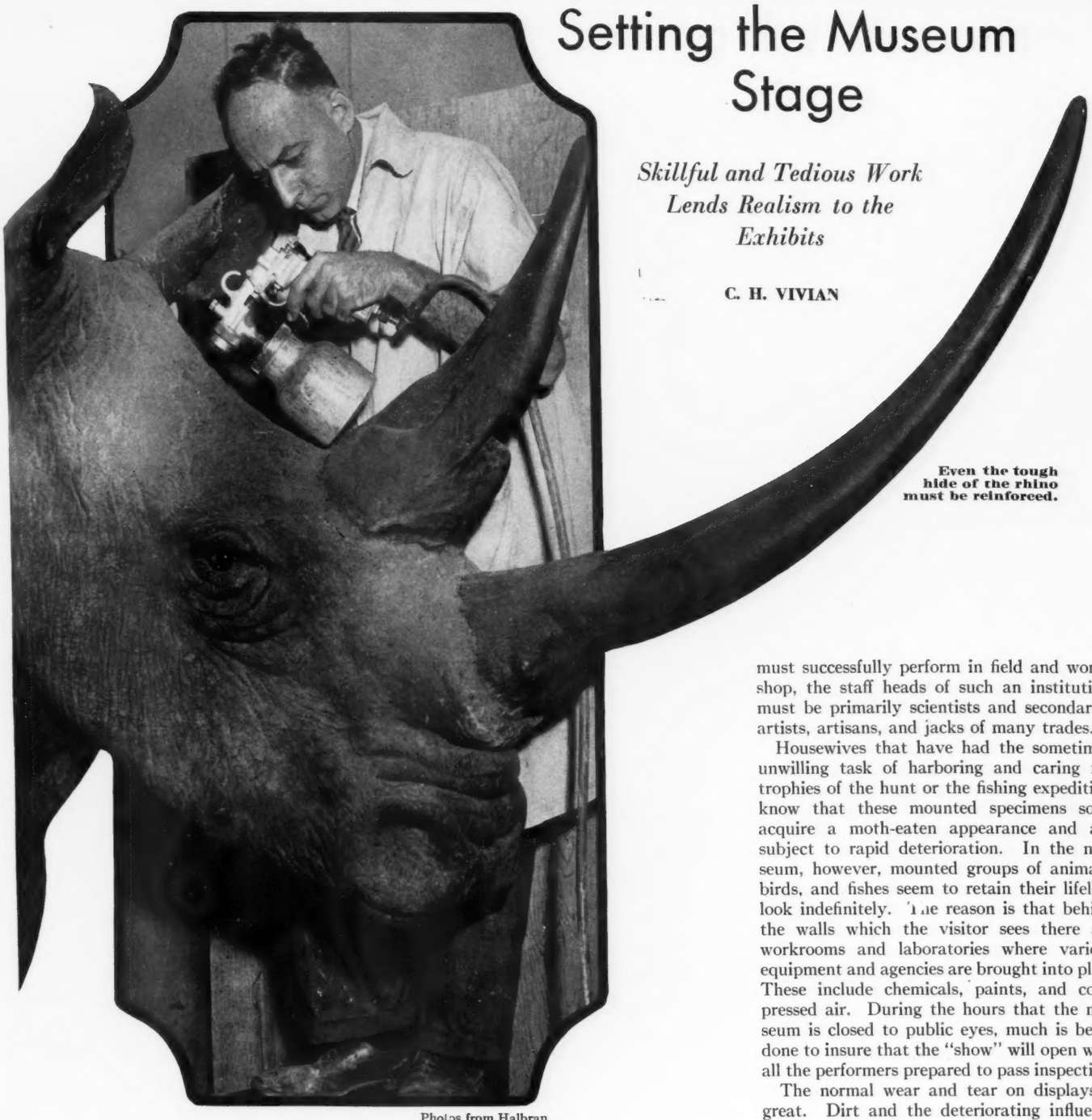


How museum attendants go about cleaning a totem pole.

Setting the Museum Stage

Skillful and Tedious Work Lends Realism to the Exhibits

C. H. VIVIAN



Even the tough hide of the rhino must be reinforced.

Photos from Halbran

A MILLION persons visit the American Museum of Natural History in New York every year. Probably few of them fully comprehend the amount of work that is expended in arranging and maintaining the exhibits. The fact is that in this great institution, and in similar ones elsewhere, painstaking care is exerted to create an atmosphere of reality in the displays and unrelenting effort is put forward to preserve this aspect of verisimilitude.

Intensive studies in the field attend the collection of specimens for all animal groups to insure that the details of assembly and the settings will be authentic. These precautions include the taking of generous notes and the making of photographs, sketches, and color paintings. Back in the museum, slow, tedious work is required in the actual preparation of the groups, and there important steps are taken to facilitate their proper preservation.

The maintenance of specimens over periods of many years calls for not only regular inspection and treatment but also expert knowledge of what to do in each case and how best to do it. There are thousands of exhibits in every large museum. They are brought under roof from every climate; are of animate and inanimate origins; and each class demands specific attention. Sometimes skilled craftsmanship is required. As a result of the manifold and diverse functions that they must successfully perform in field and workshop, the staff heads of such an institution must be primarily scientists and secondarily artists, artisans, and jacks of many trades.

Housewives that have had the sometimes unwilling task of harboring and caring for trophies of the hunt or the fishing expedition know that these mounted specimens soon acquire a moth-eaten appearance and are subject to rapid deterioration. In the museum, however, mounted groups of animals, birds, and fishes seem to retain their lifelike look indefinitely. The reason is that behind the walls which the visitor sees there are workrooms and laboratories where various equipment and agencies are brought into play. These include chemicals, paints, and compressed air. During the hours that the museum is closed to public eyes, much is being done to insure that the "show" will open with all the performers prepared to pass inspection.

The normal wear and tear on displays is great. Dirt and the deteriorating influence of passing time take their toll, while insect life and bacteria are arch enemies of all mounted animals, birds, and fishes. To combat the destructive forces of these last-named agencies, it is customary to poison the insides of skins as soon as the specimens are collected. During transit to the museum they are protected against moths by naphthalene, and salt is applied as a temporary preservative. Once they are mounted, the displays are given systematic attention—the measures that are taken to maintain them being varied to meet individual requirements. In most cases, liquid protective reagents of one sort or another are freely used, and these are quickly and efficiently applied by means of compressed air.

A diver securing coral in the Bahamas, as seen from the Williamson tube.

One of our illustrations shows treatment being given a rhinoceros. As in the case of all hairless animals, a celluloid spray is used as a cleansing material and preservative. Another view depicts mounted fishes being protected against parasites. A mixture of celluloid and acetone is sprayed on to hermetically seal the myriad openings beneath the scales. Where desired, colors can be added to spray materials to renew or enhance the natural hues of the specimens.

Even such objects as totem poles, birchbark canoes, and the countless other museum pieces of inanimate origin undergo marked changes if they are not properly cared for. They are given regular cleanings in which the blowing power of compressed air and the suction of air under vacuum are of importance. Incidentally, some colored articles, among them totem poles, are altered by the bleaching action of daylight, and for that reason are assigned semidark stations in the museum.

But this periodic cleaning and treating of exhibits is, after all, a routine operation that has been reduced to a standardized procedure. It is in the procuring and preparing of important new specimens that the museum specialists are called upon to exert their versatility and to cope with unusual problems which require great resourcefulness. One such extraordinary exhibit is now nearing completion at the American Museum of Natural History, and will occupy a prominent place in the Hall of Ocean Life. It is a group made up of coral, transplanted hundreds of miles and assembled exactly as it grew just off the Island of Andros in the Bahamas. It weighs 40 tons, and is supported by and upon 6 tons of structural steel which has been so skillfully fabricated that none of it is visible from the spectator's point of view. Approximately $100,000 has been expended on this display, which surpasses anything of its kind in existence. So faithfully does it portray its subject matter that it will prove of inestimable aid to students. It makes it possible for New York people to see a true panorama of ocean life without spending the time and money which a voyage would necessitate. Moreover, the display has been arranged so that the observer will see it as though he were walking along the ocean floor. This illusion gives him an authentic impression that he could not get in the case of a real coral reef without descending beneath the water's surface.

Ten years have been spent in bringing this exhibit into being. It is the result of four expeditions to the West Indies, and of countless hours of tedious, painstaking work by museum specialists. It constitutes a *bona fide* reproduction of submarine life, lifted bodily from its native setting and given a new one as much like the old as the talents of man can provide. Even the surface of the water has been cleverly imitated with rippled glass; and overhead the artist's brush has portrayed a vista of Andros Island and the horizon beyond. Dr. Roy Waldo Miner, curator of living invertebrates at the museum, who conceived this unique display and directed its assembly, has described it as "forty tons of coral, their serrated branches interlaced as of old and once more invested with the delicate hues that gave them their pristine beauty, while above them again spreads the mirroring quicksilver of a simulated watery surface overarched by the blue of a painted tropic sky!"

The coral barrier from which the specimens were obtained skirts the eastern shore of Andros Island for more than 100 miles, and is recognized as the finest reef in the West Indies. As a preliminary to the gathering of material, Doctor Miner visited the Bahamas in 1923, inspected and explored the reef, and made arrangements for the expedition of June, 1924. At this time Doctor Miner was accompanied by three artists and modelers of the museum staff. At Nassau they were joined by Dr. J. Ernest Williamson, who placed himself and his submarine tube at their disposal. With the aid of this marvelous equipment, the party was able to descend underwater to make colored sketches and still and motion pictures which were to guide them in the subsequent work of assembling the coral just as it occurred there. The water was so clear that they could see perfectly 150 feet ahead through the tangled jungle of marine growth.

The pictures and mental images made, the scientists resorted to diving helmets to enter the coral forest and to secure the specimens they desired. Around each, in turn, was passed a chain attached to a hoist which was floated on the water surface by pontoons. Thus supported, the specimens were towed to the nearby beach. The portion of the reef that had been chosen contained many varieties of coral; and the individual pieces obtained ranged from delicate growths of small size up to one massive section 12 feet long and weighing 4,000 pounds. On the beach, the specimens were kept wet until the thin surficial living animal tissue decayed and sloughed off and exposed the white limestone skeleton underneath. Surrounded by sponge

clippings to protect it, the fragile material was packed in 31 wooden boxes and shipped to New York.

In the laboratories and workshops of the museum there then began the laborious but interesting task of preparing the various pieces for exhibition. This involved duplicating with inanimate materials the living tissue which had been removed. To anyone who has closely examined the intricate formation of some coral surfaces, the magnitude of this undertaking will be apparent. Not only were the delicate traceries and convolutions of the figures faithfully simulated but the exact colorings which characterized them in life were also imparted to them. Before a start could be made on these phases of the work, though, every piece had to be thoroughly cleaned—an operation which consumed six months of effort.

The imitation surface covering was composed of beeswax, applied in a liquid state. Much of this work was done with the aid of compressed-air spray guns. Beeswax forms a suitable base for coloring reagents and also serves to close the minute crevices and openings in the skeleton rock and thereby to prevent the crumbling and deterioration of the limestone. The coloring was done with oil paints—the artists using as guides the water-color sketches which had been made at Andros. Some varieties of coral exhibit three colors, and lifelike reproductions are exceedingly difficult to obtain, especially where there are intricate surface convolutions as in the case of brain coral. Spray guns were successfully used for much of this work, but the more delicate operations had to be carried out by hand brushing.

Some of the more fragile specimens were broken in transit in spite of the care with which they were packed, and these had to be restored. Each end that had come off was fitted into its original place and fastened by means of drilling and pegging with wire pegs. Joints were cemented and then colored so as not to show.

Meanwhile, Chris E. Olsen, modeler in Doctor Miner's department, had been constructing miniatures of each main coral mass on a scale of 1 to 16, and these were assembled so as to conform to a design of the completed exhibit which had been prepared under Doctor Miner's direction when the display was first being considered. This composite model served as a basis for actual construction, fixed points thereon being projected on the larger scale that was being followed. The housing structure for the exhibit had been prepared by this time and provided an interior space 30 feet high, 16 feet across the front, and 16 feet deep.

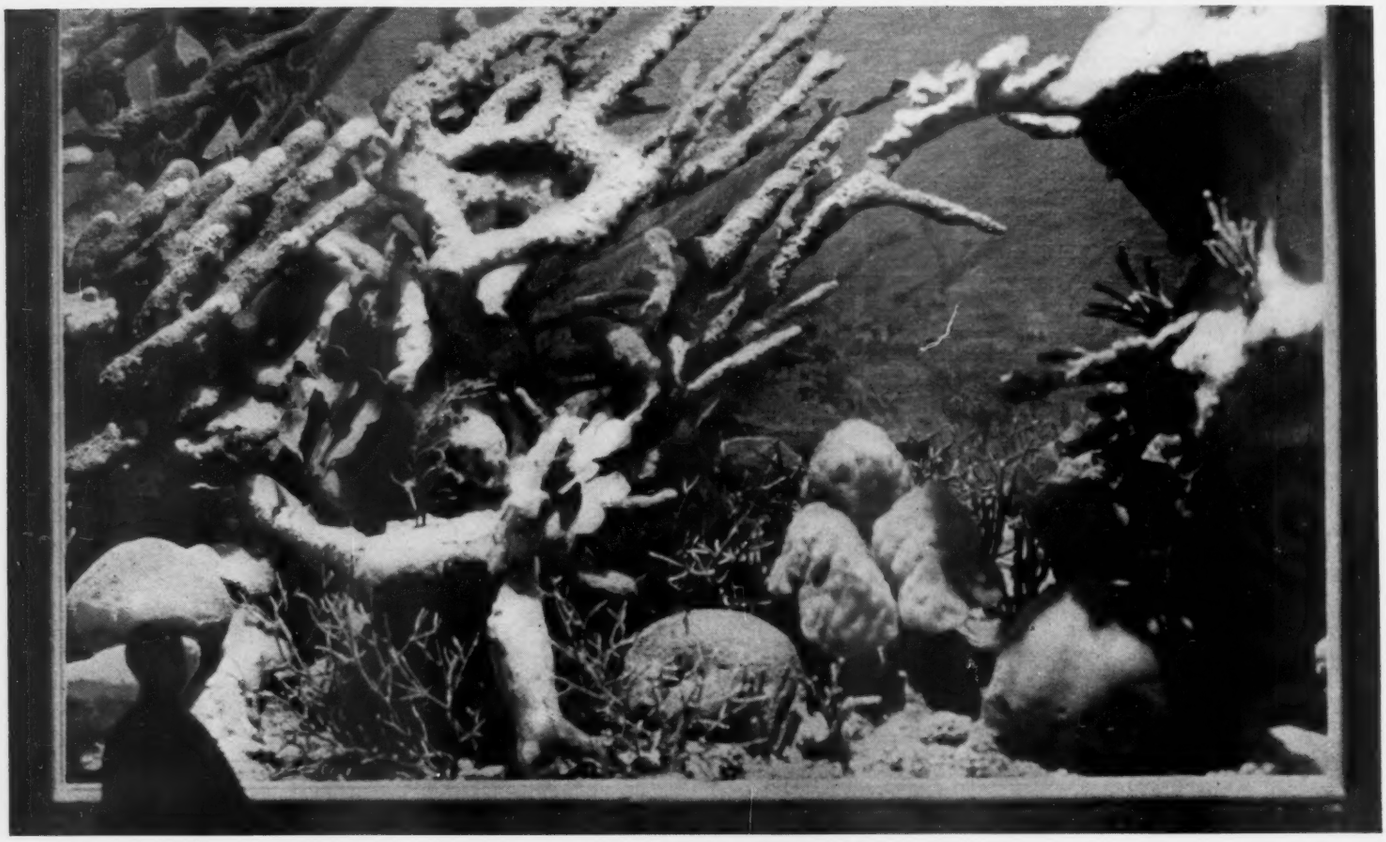
Restoring the natural appearance of coral with an air brush.

The steel framework to support the coral was erected by a skilled ironworker. Channel irons were used for the main members, and from them branched scores of smaller pieces, each of the particular shape and dimensions that would enable it best to serve its intended purpose. The form and position of each section of the frame were accurately determined by first taking the coral mass which it was to hold and suspending it in the position it was to occupy when it became a part of the composition. The fabricator then made the supports to fit the requirements. This process involved repeated trials and alterations, and was continued in each instance until the framework was so placed that it would afford adequate support and yet be hidden from view from the front of the exhibit. Inspection of the illustrations accompanying this article will convey a more complete impression of what this entailed than can words. Suffice it to say that the overhanging members of cave formations and the numerous branches of certain varieties of coral were the cause of many problems which called for great ingenuity and infinite patience in their solution.

To again quote Doctor Miner: "It was always a case of try and cut and try again, bending and fitting according to need, remembering always the overhangs and caverns planned in the composition of the group, and yet compensating by braces judiciously placed according to need, or by concealed rods bolted into the floor to act as checkreins with turnbuckles adjusted to give the right tension.

"This was a steel structure which no blueprint could map out beforehand, and required the most continuous impromptu exercise of engineering ability and adaptable ingenuity, qualities for which Louis Beauvais has shown especial capacity during the three years in which he has been patiently fitting six tons of steel parts into this group with which to support our forty tons of coral in its proper anchorage.

"The principal mass of coral trees rises in the left center of the foreground, the steel supports completely concealed by modeling representing eroded masses of dead coral



A portion of the 40 tons of coral.

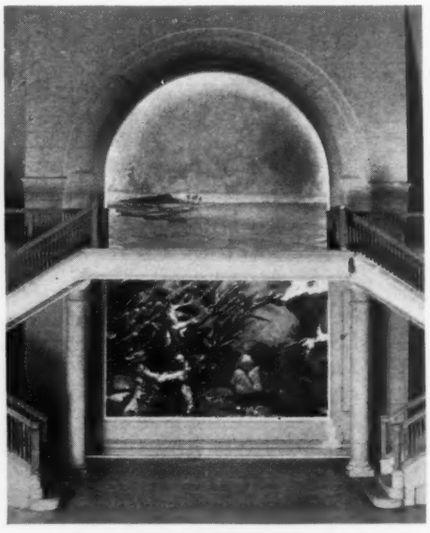
branches forming arches and caverns.

"To the right of the group a great cavern of eroded and welded limestone and coral has been modeled. This reaches the surface to form a cay of grotesquely eroded rock awash at low tide. These features have been modeled over the iron framework by Mr. Olsen, using first a base of stiff wire screening, over which is spread plaster of Paris mixed with excelsior, forming a rigid matrix. Over this, in turn, is brushed a layer of beeswax to form a finished surface, and finally the whole is colored with oil colors to represent dead coral limestone, coated with encrusting algae, bryozoa, sponges, and other living forms of beautiful color tones, as in the actual reef."

Many hundreds of small and delicate pieces of coral have been individually treated and colored and will be inserted in their proper relative positions. In the skilled hands of Herman Mueller, expert glass modeler, various fragile polyps and other sea organisms have been reproduced and colored and will occupy places in the foreground of the assembly. Here, again, the air brush has been an important aid,

To give the illusion to the observer that he is looking through crystal-clear water into a gradually obscuring haze, huge sheets of glass have been erected behind the group and on them Mr. Olsen has painted the outlines of other coral growths as they actually appeared in the middle distance during the descents into the waters off Andros Island. Back of these transluscent screens, other submarine scenes have been painted on the curving wall. Concealed lights of varying intensities will give the soft tones that characterize increasing horizontal depth of water. The foreground will, of course, be illuminated so that every detail of the maze of ocean growth may be seen.

As a final touch to the underwater vista, scores of fishes that inhabit the waters from which the coral was taken will appear as though pausing momentarily in the act of swimming about. This effect will be accomplished by suspending them on virtually invisible wires formed of molybdenum. A special trip was made to the Bahamas by Doctor Miner and a party to secure typical fishes for reproduction. As soon as the specimens were caught, color drawings were made of them by F. L. Jaques, museum artist, and plaster molds were taken to serve as guides later when making the wax casts and painting them true to life. In all, 65 species of fishes were obtained, and all will be represented in the group. A fourth expedition was devoted to the gathering of sea plumes and sea bushes to be included in the display.



The coral display as it will appear when completed.

As one of our illustrations shows, the exhibit will be mounted so that the observer, standing on a balcony at the water line, will receive the impression that he is peering underwater at a forest of coral. Above the simulated water surface, on a curving canvas which terminates overhead in a half-dome, Mr. Jaques has painted a likeness of a tropical lagoon with the low lines of Andros Island in the background and a cloud-bedecked sky above it. From this balcony the visitor may descend to the floor level by either of two stairways at the sides. There, seemingly standing on the ocean floor, he will look straight into a wondrous growth of coral and its attendant marine life. From this floor to the center of the arch above is 35 feet.

The visitor who enters the new Hall of Ocean Life will find himself on a gallery overlooking the main floor. About him will be many interesting exhibits, but his eyes will be drawn to the brilliantly lighted coral group directly opposite him in the center of the far wall.

Burning Through Metal Barriers Underwater

Oxy-Electric Torch in Present Form Steadily Widening Its Usefulness in Subaqueous Work

R. G. SKERRETT

Diver testing his torch before submerging. Note steaming vapor rising to the surface at his left.

Diver with an oxy-electric torch ready to go down to cut metal underwater.

Left—Diver and pipe section cut by him from a 36-inch main lying at a depth of 22 feet in muddy water. A complete circular cut was made in the 1⅝-inch-thick cast iron in half a day.

"HAVE hit a whale. Propeller damaged. Must make repairs at dock."

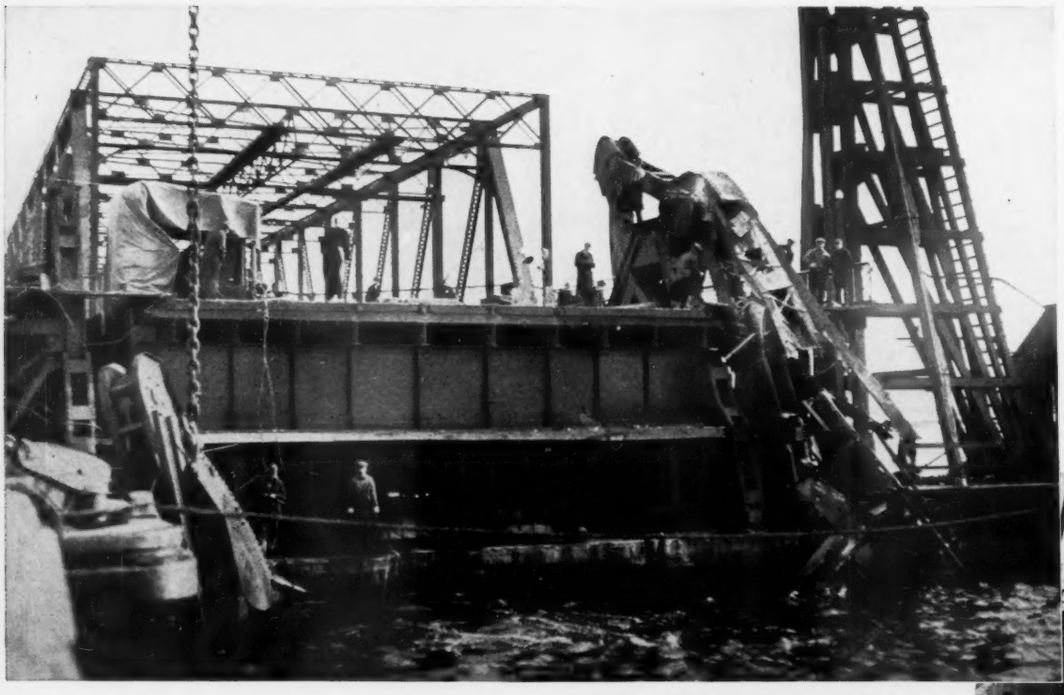
Such was the wireless message received a short while back by the New York agents of a well-known transatlantic line of speedy steamships. Plainly, time had to be saved lest the great craft be delayed in getting away on her return run to Europe and her owners forced to pay a tidy sum on that account. The situation could not be dealt with in the ordinary way.

When that ocean greyhound struck the sleeping whale in the dark of night, the stunned animal slid sternward where one of the whirling propellers gave the creature a parting blow. Whether or not that blow made an end of the whale, it did, for certain, break a sizable section from the tip of the punishing blade. The piece of bronze that was knocked off was large enough to unbalance the screw so that the ship shivered continually with the resultant vibrations transmitted with every turn of the propeller—much like the jarring action of a flat wheel on a trolley car. Ocean-going freighters make light of a propeller's limping action when something of the same kind happens on striking a submerged or water-logged derelict—the people aboard are used to rough going. Not so with the passengers of a high-class liner: those exacting patrons expect both speed and comfort while in transit, and are apt to object vigorously if their teeth be jarred by an unbalanced screw.

As soon as the steamship in question reached her pier in the Port of New York, a diver was at hand to go overboard and to deal with the injured propeller in the latest and most approved manner. Of course, he could not put a patch on the shortened blade so that it would again be normal, but he could do the next best thing—that is, cut off an equal area of metal from the tip of the opposite blade and in that way restore balance to the propeller. He did his work with an underwater metal-cutting torch. Trimmed in that fashion, the screw was able to function effectually when speeded slightly above its former rate of revolving, and there were no disturbing vibrations. What is also important, the work on the screw was done while the vessel was lying at her pier: it was not necessary to take her to a dry-dock, with the heavy expense that always entails. Furthermore, the ship was unloaded and loaded the while; and, when the day and hour for her departure arrived, she was ready for her outbound trip.

How many of us know anything about this ingenious contrivance that is playing a steadily increasing part in marine salvage by aiding divers to master difficult underwater problems quickly and effectually—incidentally saving money? American inventiveness has made the subaqueous metal-cutting torch what it now is, and things are being done with it today that would not have been thought practicable a few years ago. The torch has been progressively improved since it was first conceived. Most of us have seen the oxy-acetylene torch in service cutting and burning holes in steel and iron; but it is safe to say that most of us would be frankly skeptical if someone said that an oxy-acetylene torch could be made to burn underwater and cut metals there. The idea is contrary to common experience: we know that water will quench a flame. Even so, the Germans first showed the world how the thing could be done.

What they did was to put an oxy-acetylene torch inside a small cuplike shield which became, in effect, a miniature diving bell when the lighted torch was submerged—the pressure of the hot gases holding the surrounding water away from the flame provided the open end of the cup was held downward. That torch, at shallow depths and in moderately cool water, was used to burn metals; but it had to be lighted before the diver submerged, and he had to watch his step lest he tilt the cup upward and let the water drown the flame. A while later, two Frenchmen, at the Brest Naval Station, devised an improved



Top—Torch helping to clear a channel by cutting up the submerged steelwork of a collapsed draw span.

Right—Before this vessel could be pumped out and refloated divers with subaqueous torches had to cut away the damaged skin and patch the hole with a wooden template.

oxy-acetylene torch that could be used at greater depths and which did not rely upon the pressure of the gases of combustion to keep the surrounding water from flooding the cup. They used two cups—one inside of the other, and from the annular space between those two shields they discharged a stream of compressed air at a pressure high enough to keep the water out at the operating depth. The oxy-acetylene torch burned, as before, within the inner cup. The French torch, like the German torch, had to be lighted above water; and the diver had to hold it downward to prevent flooding. The apparatus was a step forward, but it was not altogether dependable, and a diver had many things to be mindful of even without the torch—a misstep underwater may, at times, mean grave injury if not sudden death. Such was the state of the art when two Americans, Ralph E. Chapman and J. W. Kirk, set about producing something decidedly different and much better in submarine metal-cutting torches.

Those salvage experts started out with oxy-acetylene as their gaseous medium, but they added the electric arc to insure ignition underwater and to give a much higher cutting temperature so that the tool could be used effectively in very cold water. The electrode was a carbon rod with passages through it to lead the oxy-acetylene to the tip of the electrode. The actuating arc was induced by putting the tip of the carbon against the metal to be cut and then withdrawing the electrode a fraction of an inch—the electric current instantly bridging the gap with an incandescent flame having the high temperature of 6,500° F. The arc ignited the oxy-acetylene; vaporized the water so that the arc and the gas could burn within a cavity, so to speak; and the gaseous discharge swept away the fused metal as fast as it was melted. Amazing as the torch was, it was not a perfect tool.

Despite its numerous virtues, acetylene behaves erratically when ignited at a pressure in excess of about 20 pounds—it is apt to backfire and become an explosive. Because of this, the hose carrying the gas to the torch was blown into ribbons when operating at depths that called for more than the limiting pressure to hold the water at bay. Accordingly, the use of acetylene was abandoned after it was found that the torch performed well with only gaseous oxygen as an aid to the electric arc. The oxy-electric torch will function at any depth and at any temperature range of the water. The diver carries his torch, unlighted, down with him, and neither current nor oxygen is supplied until he is all set to begin burning the metal. When ready, the diver signals for current and gas.

The oxy-electric torch in its present form is virtually a miniature electric furnace; and it goes without saying that a diver must handle it carefully lest he be burned or shocked. He is expected to wear heavy rubber gloves to shield his hands from scattering pellets of white-hot metal; and those gloves are a partway protection against electric leakage, just as are all the rubber parts of his diving dress. But the hood and the breastplate are of bronze; and an active electrode must not touch them. What may happen in such a case is thus described by an expert in the use of the torch: "I was once working in a strong current and holding my torch somewhat loosely. Before I knew it, an eddy caught the hose and pulled the torch out of my hand. My one thought was to recover it, and I failed to signal to switch off the juice. The water was cloudy with silt, and I could see only a foot or two away. Suddenly, the torch swung back from an unexpected direction and hit my breastplate a glancing blow, but even in that fraction of time it burned a long hole across that metal surface. Luckily I was neither burned nor stunned, and instantly I signaled to draw me to the surface. I was pulled up before my suit could fill. It was a close shave, and it taught me a lasting lesson."

While alternating current might add to the efficiency of the torch, direct current is used because it is safer. Alternating current attracts a metallic body, while direct current exerts a repulsive force; and a torch energized

Top—Steamer sunk in a collision. Note the head of the diver who is cutting up the tangled wreckage.

Left—A 20-ton mass of crumpled plating and angles cut away from the damaged stern of a steamship so that she could be refloated and placed in dry-dock for repairs.

by the latter is less likely to shock an operator if he get too close to the electrode. Knowing how dazzling is the light of an electric arc, it will probably surprise many to be told that divers have at times to toil in waters so thick with silt in suspension that the arc of the torch is invisible a foot away from the faceplate of the hood. When working under such conditions, the diver has to depend upon his ear to inform him whether or not the torch is functioning. An active arc underwater sounds like a boiling kettle; and to that sound is added a singing note that is punctuated with the crackling explosions of bits of metal undergoing rapid expansion and contraction. These sounds indicate that the diver is holding the electrode the right distance away from the metal to be cut, say, about ¼ inch. It takes experience to handle a torch correctly in such a situation.

Instead of being round, as it formerly was, the present-day electrode is rectangular in cross section, with two broad surfaces and two narrow ones. This form makes it possible for the diver to use a corner edge or either a narrow or a broad surface when cutting. The tool is, therefore, just that much more adaptable. Because of the intense heat of the arc and the forceful and sweeping action of the oxygen jets, divers can now cut metals as hard as cast iron and manganese bronze—in fact, the torch has yet to encounter in its field of service any metal that it cannot cut, and cut quickly, and it will do its work in any position in which it can be held by an operator.

Once so often ships back into wire cables and get them messed up with their propellers so tightly that the screws are jammed. The crippling mass may consist of 20-odd turns of a cable. Before the oxy-electric torch was perfected, these metallic bonds were loosened toilsomely with chisels and with saws—a diver did a good job if he cleared a propeller in that manner in a week. Now, the underwater torch will get rid of the hampering bonds in the course of a day. Formerly, in refloating sunken ships, it was the practice to shatter bulkheads with dynamite so that the water could flow successively from compartment to compartment until it reached one from which it could be pumped overboard. The charges of explosive did much damage to a vessel's structure—adding just so much more to the cost of repairs. Holes burned for the same purpose with an oxy-electric torch can be easily sealed with plates that entail only a modest outlay.

In salvaging ships it is often necessary to cut away much torn and twisted metal and also to make holes for bolts so that either metal or wooden patches can be placed over a damaged area preparatory to refloating the craft. The underwater torch is now utilized for these different operations, and can do the work better and faster than it can be done in any other way. Indeed, the modern marine salvor and the diver in his many subaqueous tasks would be greatly handicapped if the oxy-electric torch were not available. In its present form, the tool is the outcome of the varied and the ever-widening demands made upon it.

It should be easy to understand how the same torch could be used in cutting away submerged metal parts of old bridges, especially when the bridges have collapsed and are blocking busy waterways. In one recent case of the latter sort the torch was employed in cutting through six heavy steel plates that were bound together with numerous rivets to form the structural units of a drawbridge. Steel sheet piles are utilized extensively in building cofferdams around underwater areas that are to be pumped out and excavated in advance of setting foundations on bedrock. This was done prior to constructing the piers that support the monumental towers of the George Washington Bridge, which spans the Hudson River. After the ponderous piles had served their purpose they were cut off at a prescribed depth with the oxy-electric torch.

A frequent use of the torch is in cutting out defective sections of water mains so that replacements can be made speedily and with the least disturbance of adjoining sound sections. Many mains of this sort lie on the beds

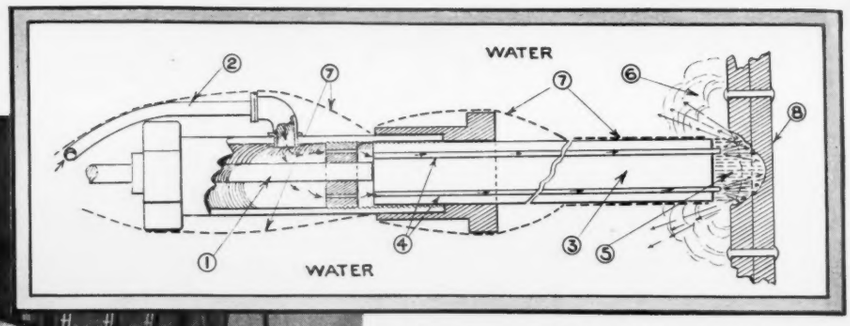
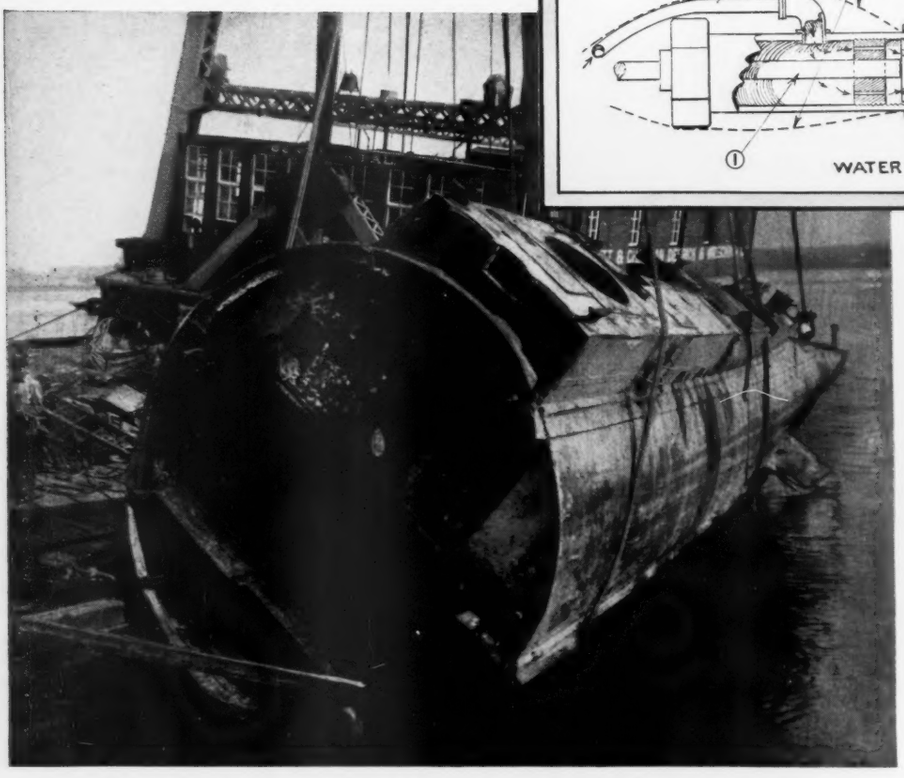


Diagram of principal features of the oxy-electric underwater torch. 1, Electrical conductor; 2, pipe delivering high-pressure oxygen to torch; 3, carbon electrode; 4, small pipes through electrode by which oxygen reaches tip of torch; 5, flaming arc; 6, vaporous cavity in which the arc burns the opposing metal; 7, covering of friction tape which serves to insulate the torch; 8, steel plates being burned through with the torch.



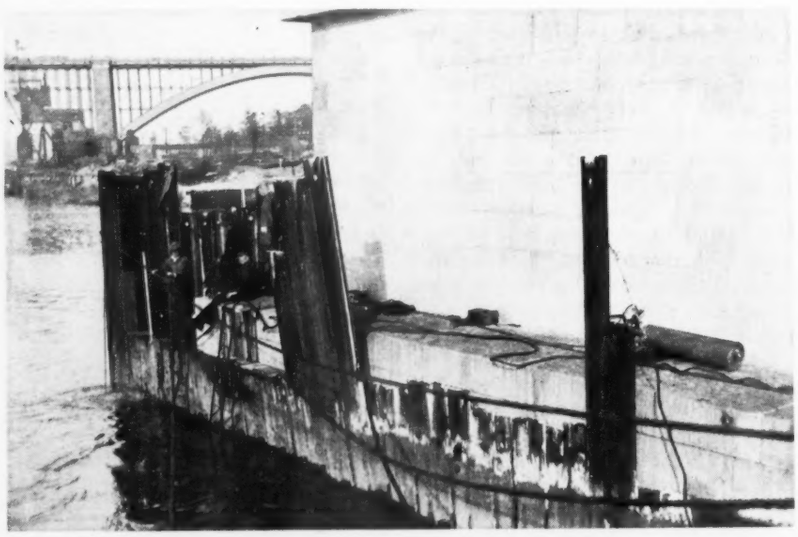
Part of a sunken submarine that was cut into three sections with the underwater torch so that the craft could be salvaged for its metal.

of rivers. The largest one so dealt with to date is a 72-inch line of pipe that carries water to a chemical plant. The main reaches out from the shore more than 1,000 feet and rests on the bottom of a lake. It had become clogged with deposits, and the flow of water to the factory was much reduced. The problem was how to clean it out without needless hazard to the divers required for the job. The solution consisted in cutting four big holes at intervals in the top of the main; and through these the divers got into the pipe where, in consequence, they had relatively short unit sections to clean. Afterwards, the disks of metal were fitted with collars of heavy plating so that they could be used to plug the manholes.

The interior of a sunken ship bristles with pitfalls for any diver entering it. The surfaces on which he may have to walk are usually inclined and slippery with accumulated slime: a misstep may spell disaster. Swimming creatures, among them sharks, brush against a diver and add to the uncanniness, if not the hazard, of his surroundings. By the aid of the submarine torch it is possible for a diver to avoid devious and dangerous passages and to get to his objective more directly. This was proved a few months ago when the torch was used successfully in recovering fully $100,000 worth of bullion and specie that had been stored in the steel-clad strongroom of a foundered steamship. The door of the strongroom was locked and could be reached only by following a round-about route; but the deck forming the ceiling of the stronghold was accessible through a convenient hatchway. Therefore, the thing to do was to cut a good-sized opening in that overlying deck.

The diver entrusted with the task did his work well and quickly; but when he got into the strongroom he found that the floor of that compartment had been shattered when the ship hit the sea bed and that the treasure had dropped through and into the hold beneath With that fact established, it was not difficult to enter the cargo space through a large open hatch and to recover the bullion and the specie. Although the torch failed to uncover the bars and coins, still it was the means by which the treasure was located and the salvage work was made easier.

No one can tell what next the torch will be called upon to do—it is like any other adaptable tool; but it is a reasonably safe bet that it will make good if placed in the hands of men trained in its use, and especially when those operators are under the guidance of the salvage experts who have helped to bring it up to its present efficiency. The torch is another example of how the thing thought impossible yesterday can become an accepted commonplace of today. As L. F. Hagglund, of the Under-Water Metal Cutting Corporation, expresses it: "Each job teaches us something new; and we, too, wonder what next we shall be asked to do with the torch; but we are sure it will do everything we expect of it."



This supporting pier for a large bridge was constructed within the enclosing cofferdam of steel piling. The pier has been completed, and a diver is at work at the far end cutting off the piles just above the river bottom.

A modern Pueblo Indian girl.

The Santa Fe Trail of Today and Yesterday

The Colorful Pueblos Still Hold to the Life of Their Forebears

LAWRENCE A. LUTHER

NEAR the trading post at Ramah, in New Mexico, is a unique autograph album—a huge, triangular cliff of light-buff sandstone that rises sheer from an arid waste of rock, sand, and scrub timber. It seems that the early Spaniards passing that way stopped to inscribe their names and to publish laboriously on stone the nature of their business. The inscriptions are still legible; and, couched in the grandiose phraseology typical of the period, they imply empire-molding conquests of kings rather than weary desert marches by police patrols or small regiments.

It is a desolate spot; and, if you like to combine gymnastics of the body and of the imagination, you can scale the rock and paint into the rugged landscape dusty sixteenth-century cavalcades of friars and petty potentates. But these were comparatively modern interlopers in a land of great antiquity, for you are standing almost on the ruins of one of its fortified towns. The high walls of rock and adobe had melted down to mere mounds centuries before the first Spaniard came. A hewn stairway, defaced by the attrition of wind and rain, leads up from the plain below. You gather fragments of excellently wrought and colored pottery as you recreate to suit your fancy the native actors—several hundred of them—in a drama fairly hoary with age. Were they annihilated by enemies or pestilence, or did they desert their "Gibraltar" to secure some agricultural or other economic advantage? All the clues that remain are the ruin, the stairway, and the undecipherable Spanish pictograph inscriptions interspersed among them.

Crossing the wilderness not far from this great rock on a day in April, 1539, a strange old-world adventurer approached a citadel in quest of gold. He was a negro, one of four survivors of a Spanish force of several hundred shipwrecked on the Florida coast, who had eluded the hazards of an overland journey of some 3,000 miles and eventually enlisted as the servant of a Franciscan monk in southwestern Mexico. Entering a veritable apartment house on one of the rugged mesas in what has since become the Zuni Reservation, this ambitious harlequin, dressed in the regalia of an Indian medicine man, demanded both treasure and entertainment. His master, Friar Marcos, had been spurred northward through the inhospitable and uncharted desertland by altruistic zeal and simple avarice. But Esteban, becoming drunk with the lust of conquest, hurried ahead to be the first to enter that mythical mecca of adventurers, the Seven Cities of Cibola. The savage war chiefs of Zuni promptly dispatched this grotesque pretender and cast his body off the mesa wall, thus repulsing the first known attempt at Spanish conquest in what is now the United States.

The small army of cavaliers in the entourage of the Mexican premier appears to have had no taste for agriculture or for other industry in the New World but to have dreamed always of finding some vast repository of wealth akin to the rich spoils taken by Cortez and the early *conquistadores*. Their precarious economic outlook, aversion to work, and penchant for unscrupulous adventure obscured from their vision the advantages to be derived from exploits of a constructive nature. The peculiar background of the age had bred in those scions of a decadent aristocracy an enjoyment in reaping where other men had sown; but the destitute tribes of Mexico furnished scant spoils beyond slaves, for which the market soon proved wholly inadequate.

In the terror inspired by capture and insistent questioning, a native finally sought to indulge the gold lust of his captors by describing the fabulous wealth of certain cities of many-storied houses in the North. This poor savage appears to have satisfied every avaricious vision of his questioners, painting a mirage in which seven great communities ate and drank from golden vessels while they guarded vast hoards of jewels and virgin metal. The tale grew rapidly in glamour and detail, until men chafed at delay and made ardent proposals concerning ways and means of conquest. When Friar Marcos—who had suffered much danger and discomfort ostensibly to save human souls—returned and told of viewing one of those seven cities from a distance, and pictured it as a group of well-built structures larger than any in Mexico, the soberer and more conservative could scarcely remain incredulous, and an

Tamping ballast under ties with air-operated tools.

Three portable air compressors supplying air to "Jackhamers" for widening a cut on the Santa Fe line near Gallup, N. Mex.

elaborately equipped expedition was sponsored by the viceroy and the king.

Most of us are somewhat familiar with details of the conquest of New Mexico by Coronado, and it is difficult for us, today, to credit the gullibility of those militant men who fitted out an army with a retinue of a thousand servants; sent a naval commissary up the Pacific Coast under Alarcón; and endured hundreds of miles of travel through the wilderness to find cities which were largely the creation of their own unrestrained imagination. Narratives of Coronado's attack on the first pueblo relate that the strings of the crossbows had suffered so severely from heat and wear that they broke, and that many men were too weak to stand. These heroic cohorts apparently depended for subsistence upon the scant and hard-won stores of maize in the Indian villages.

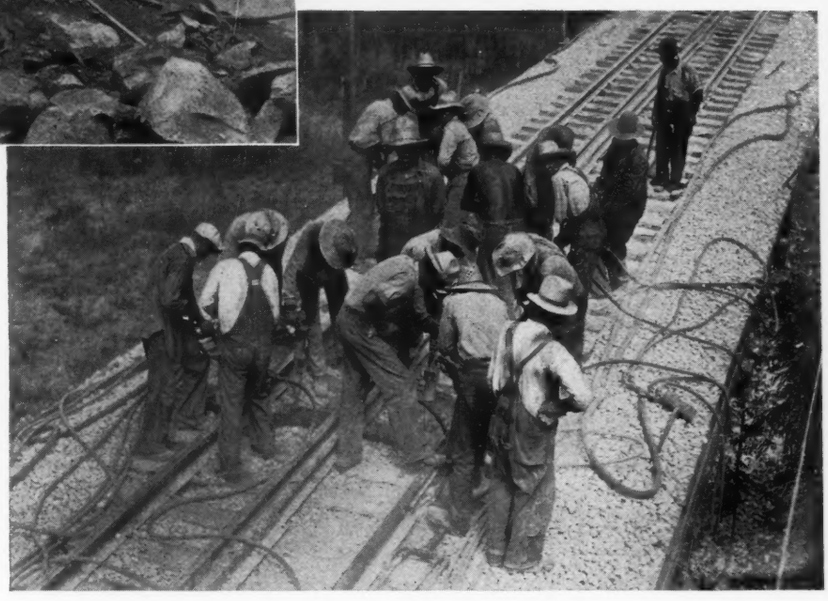
After exploding the Cibola myth at a great cost, it is surprising to find Coronado listening to the tale of a decoy employed by the distressed pueblo dwellers and following this guide many leagues across what are now Colorado and Kansas to discover a second great fountain of wealth, the Gran Quivira. In southern Colorado there are still traces of a small adobe fortress used by Coronado's men on this march, as indicated by remnants of military fittings discovered in nearby graves.

But if we are constrained to be amazed at those armor-clad cavaliers, we find much to interest and to admire in the people they conquered and in the then isolated country in which they lived and evolved their distinctive civilization and architecture. How many of us have ever paused to note that centuries before Columbus had laid the cornerstone of the New World the moccasined feet of those peace-loving Pueblo Indians had worn paths through solid rock on the New Mexico mesas. Their 4- and 5-story structures, capable of housing from several hundred to more than 1,000, are no longer required as citadels of defense, for which they were originally designed and admirably adapted, and remain today substantially the same in construction and setting as when first viewed by Friar Marcos and Coronado. We marvel at their size and stability and at the ingenious arrangement of rooms and apartments, for these community homes are in no way comparable to the diversified huts and houses built by our numerous other Indian tribes. It is through a study of these pueblo dwellers and a visit to the region in which they dwell that we learn best to know them. They have never been essentially nomadic; but, spurred on by their raiding neighbors, the Apaches and Navajos, and a gradually decreasing seasonal rainfall, they have striven to grow and to store sufficient corn for winter use, to defend their villages, and to maintain a tribal integrity. Four centuries of assiduous evangelizing and latter-day education find them still adhering to their aboriginal creeds and customs, weaving their blankets, and making their pottery as of old.

For years prior to the bloodless seizure of Santa Fe—the present-day capital of New Mexico—by Gen. S. W. Kearney in 1848, the land of the Pueblos was accessible from the east and south by way of the Santa Fe trail, which was then one of the few important western roads. A considerable business was carried on annually by wagon caravan between Santa Fe and various points on the Missouri River and Chihuahua in Old Mexico. A sizable traffic in slaves was once conducted over the latter route—the Mexican traders purchasing war captives from the nomadic tribes of the plains with cloth and trinkets at the annual *fiesta* at Taos, a festival which is still observed. American conquest accelerated overland trade; and some of the California bound "forty-niners" took this road. Stagecoaches began to carry mail and passengers over the route with some regularity in spite of the frequent depredations of the numerous and powerful Indian tribes—the Pawnees, Comanches, and Kiowas—inhabiting the prairies. This historic trail through the wilderness did not attain the status of a true highway until it was graded and equipped with crossties and rails by the builders of the Santa Fe Railway.

There is a striking contrast in the motives and methods of the creators of this line of rail and of the Spanish pioneers who preceded them in the sixteenth century. Where

Rock drillers at work in a cut near Gallup, N. Mex.



One reason your train rides easily—a 16-tool tie-tamper crew giving the rails a firm foundation near Warnoka, Okla.

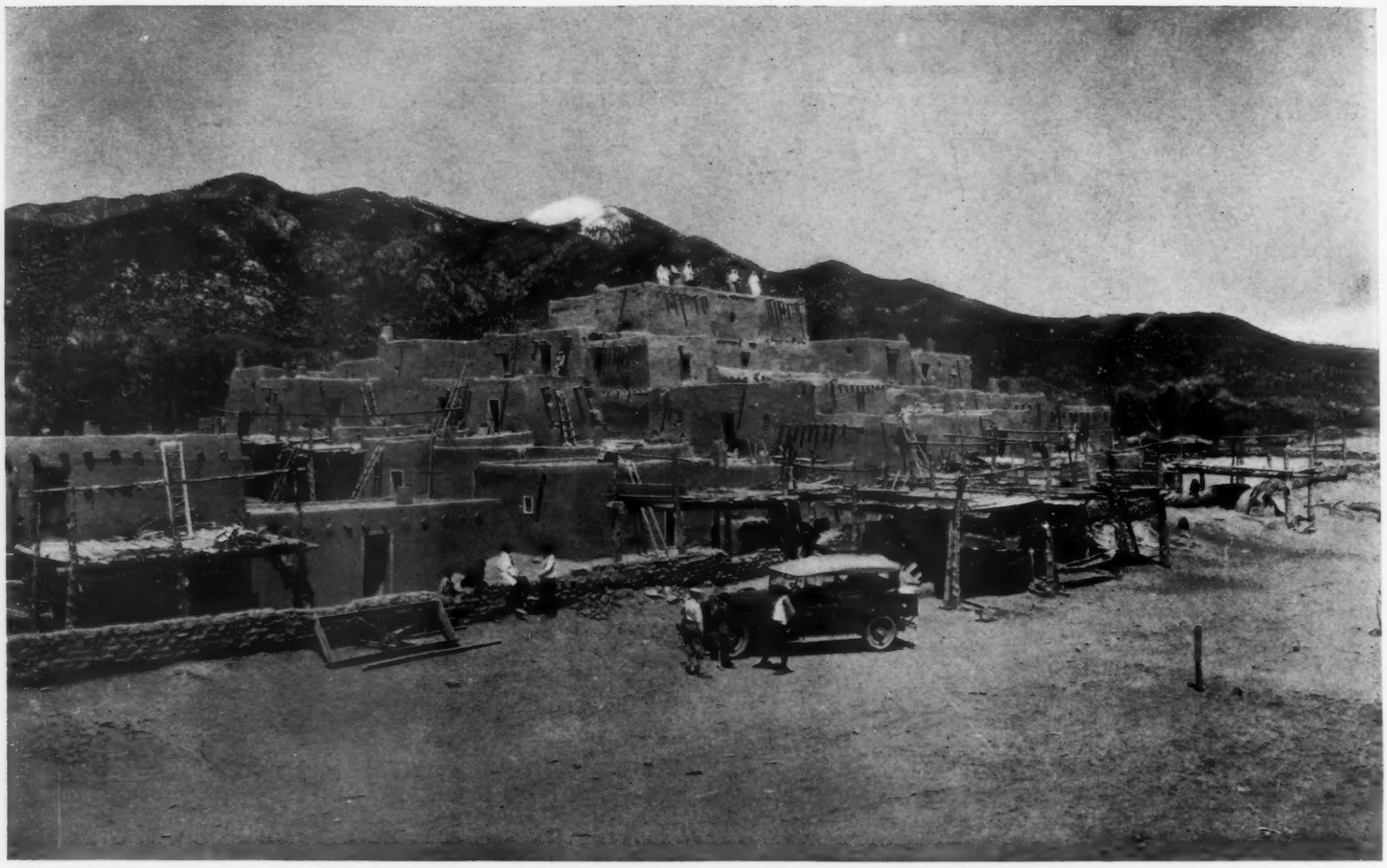
the Spaniards blazed trails in the hope of levying tribute, the railway builder resolutely assumed the task of creating wealth by opening up the country to settlement and development. In 1869, Cyrus K. Holliday, after seemingly insuperable delays and discouragements in effecting the building of a few miles of railroad from Topeka, Kans., west, demonstrated to his associates the feasibility of his dream project—the extension of the line to the Pacific Coast. Considering the very meager amount of Federal subsidy obtained, consisting entirely of land grants, the railroad was built with surprising rapidity. The story of its financing, often with bond issues by the towns it was to serve, is highly inspiring.

This was the era of the great railway builders, when Huntington, Strong, and Gould were playing for huge stakes in money and in tactical advantage. In these stirring times the courts were not the only umpires employed by disputants. Threat and violence were not uncommon in clashes between rival interests; but a climax was reached when stone forts were constructed in the Royal Gorge of the Arkansas River and garrisoned with well-armed forces while officials of the Santa Fe and of the Denver & Rio Grande fought legal battles over the coveted franchise which would bring a line of rail into the booming mining camp of Leadville. The construction of the Santa Fe across the desert between Albuquerque and the Colorado River was an expensive and, in that day, a heroic undertaking. The prospect of returns from those thousands of unproductive acres traversed was nil, and the only potential source of substantial revenue lay in a connection with the Pacific Coast. It was extremely disconcerting to discover, after having bridged the Colorado, that Collis P. Huntington of the Southern Pacific, in collusion with Jay Gould of the Texas Pacific, had acquired a voting majority in the St. Louis & San Francisco, which was engaged jointly with the Santa Fe in the enterprise just referred to.

The creators of the Santa Fe—now one of our great transcontinental lines—had to remain content temporarily with a connection to San Francisco via Mojave over Southern Pacific tracks. It was therefore a source of satisfaction to President Strong when, in 1885, the opportune purchase of much existing trackage, combined with new construction, made it possible to bring Santa Fe trains to tidewater through Cajon Pass over Santa Fe rails. The outlay, owing to the accelerated exploitation of the Pacific Coast with its resultant heavy transcontinental freight and passenger business, soon proved a well-paying investment. An ambitious program of expansion, which included much new construction and the purchase and consolidation of numerous existing lines, has brought the terminals of the system to Chicago and Galveston and covered several states with a veritable network of feeder lines. A recent acquisition was the Kansas City, Mexico & Orient; and there yet remain to be built projected additions to the system, which ranks as one of the world's largest.

Originally, the road was for the most part constructed of iron rail, and no ballast was applied to the top of the grade. When floods damaged long sections of the line in 1877, much new rail of steel was laid and large quantities of rock ballast used to assure increased stability and drainage. Thus was inaugurated a program of betterment which is still in progress and which involves the expenditure of millions of dollars. It is carried on under the direction of the most able engineering talent and has resulted in speeds and standards of safety undreamed of by the pioneer builders.

Santa Fe officials have been among the most progressive in adopting modern maintenance-of-way equipment. Now, instead of depending on men and horses as sources of power, they use pneumatic tools and machines for the laying of rail. Track-mounted, motor-driven compressors supply air to spike drivers and wrenches that tighten joint bolts on new rail and remove bolts from old, discarded rail. These compressors are not restricted to a few services: they have a wide and steadily increasing field of application. They operate tie tampers in various combinations ranging from four to sixteen tools; they furnish air to rock drills in quarries and on improvement projects; and they are indispensable in the erection and upkeep of bridges and buildings.

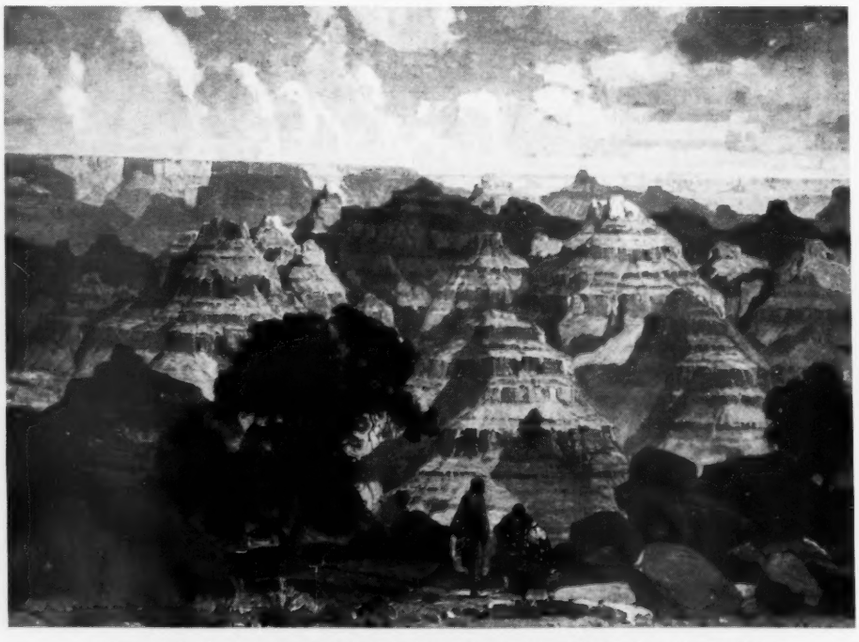


The Eastern Pueblo at Taos, N. Mex., as it appears today. Here the Indians live much as they did ten centuries ago. Taos is a mecca for artists and writers.

The tracks of the Santa Fe follow closely the old Santa Fe Trail west of Kansas City. Every mile of this highway is full of historic interest; and each community along its way treasures a diary recording its eventful early days. Of these frontier towns Dodge City was, perhaps, the favorite rendezvous of buffalo hunters, cow hands, and those desperate adventurers that migrated westward to avoid too intimate a contact with advancing civilization. There are men still in the employ of the Santa Fe who saw the tag-end of the vast herds of buffalo whose hides were shipped East by the carload. This wholesale destruction of the shaggy legions of the plains resulted in substantial revenue to the railroad, and contributed steaks and roasts in abundance to mess tables in the construction camps.

Crossing Colorado and the southern flank of the Rockies over Raton Pass one enters New Mexico, a near-desert country of far distances blessed with almost perpetual sunshine and dry, invigorating air. Here one may find three sharply contrasting peoples—Indian, Spanish, and American—each one of which retains its national characteristics. Albuquerque is as bizarre as the spelling of her name, a highly progressive city in which Indians, Mexicans, and booted ranchers rub elbows with the learned and the socially elect with much of the freemasonry of the Old West, and where disciples of the Penitente faith still practice secretly their weird rites of self-chastisement.

Notable artists have discovered an ideal environment and an unusual wealth of subject matter in their colonies at Taos and Santa Fe—the distinctive productions of this school of the Southwest ranking among the best in the country. Travelers on the Santa Fe need no longer do their sightseeing from train windows, for numerous moderately priced tours take them to the most historic and interesting show places. To explore an Indian communal house centuries old; to pass roadside flocks with their Navajo shepherds; to see Navajos weaving in their hogans; to converse with Indian potters and silversmiths: and to watch women grinding corn as their mothers ground it in the tenth century are exciting and memorable experiences.



The Grand Canyon of the Colorado, as visualized by the artist, H. Puthuff, and reproduced by courtesy of the Santa Fe Railway.

Uncongenial Neighbors

Wherein a Vexatious Problem in an Air-Lift Pumping Plant Proves Quite Simple

ELTON STERRETT

"SIMPLE as a direct-current circuit," admitted the electrician.

"Plain as a cracked muffler," conceded the chief engineer.

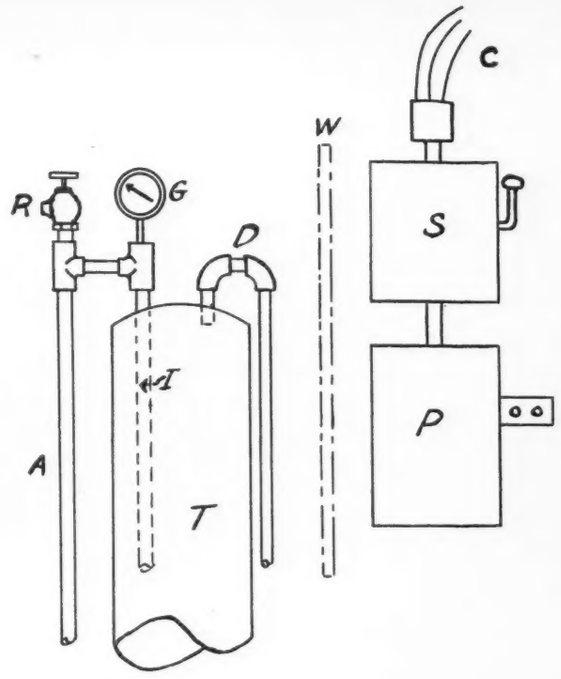
Yet for a month each of these two specialists had sought his solution of the trouble affecting the drive of an air compressor powering a deep water-well air lift, and had been baffled.

The single-stage, 2-cylinder compressor was driven through V-belts by a 220-volt synchronous motor, using public-utility current. The control panel was located in one corner of the 7x9-foot room housing the equipment. This unit usually would be started by an engineer coming on shift and allowed to pump until the various reservoirs were filled.

Trouble was encountered with the well flowing by heads and also with oil working through the compressor—splash oiled from a supply in the base. The cause of the erratic well action was correctly diagnosed as being due to the fact that it required a pressure of 130 pounds per square inch to "kick off" the well, or start the air lift to functioning, while after flow was established a pressure of 60 pounds was ample. When only the 1-inch air-supply line was used, the sudden release of pressure as the lift started and the quick build-up afterwards set up a rhythmic pulsating air delivery which inevitably resulted in the water flowing by vigorous heads.

By installing an air-receiving tank as a combination separator and surge dampener on the air line to the well, sufficient air was stored under the initial or "kick off" pressure to prevent a sudden drop as the lift began to function, and an even water flow was thus secured. This controlled the surges and prevented oil contamination of the water. Incoming air was discharged into the tank near the bottom, through pipe "I" in the sketch, and taken off for the well line at the top—the nipple extending into the tank only far enough to prevent any creeping of an oil film along the tank head.

After a few months of satisfactory operation, the unit began its erratic behavior. It would start promptly, build up the "kick off" pressure, and pump for periods of 30 minutes to an hour and a half, when the automatic control would trip the switch and shut down the motor. The electrician, summoned from the field, each time examined his part of the installation carefully, found nothing wrong, and "passed the buck" to the compressor. The chief engineer, equally certain his machine was in condition, checked everything painstakingly, and was frankly puzzled when the unit continued to cut out after short runs.



Sketch which shows how the trouble was overcome. A, air line from compressor; I, inlet to separator and surge tank, T; R, relief valve; G, pressure gauge; D, air line to well; P, control panel; S, switch box; C, current leads; W, wall of asbestos board.

As the current that was being used also powered other auxiliary units running at the same time, it was evident that the cut-out was not disconnecting because of power failure or low voltage. On occasions, when his duties permitted, the chief would cross the quarter mile to the well, there to spy on the pumping unit. As seems characteristic of machinery, everything worked smoothly while he was nearby, although the mysterious stoppages sometimes happened within fifteen minutes following his departure.

The trouble was spotted by a visiting engineer, to whom the difficulty was disclosed while being shown over the plant by the chief. So simple was his suggested explanation that it was scoffed at, and a test arranged to prove him wrong. The air line to the well was closed off, with the compressor at full load discharging through the safety valve atop the separator tank. Exactly twelve minutes after the start, the motor stopped, evoking the remarks which head this article. The control panel was too hot to be touched with the bare hand. The temperature-overload relay, functioning as designed, had operated.

Louvred openings to the outdoors were installed above and below the separator tank, and a foot-wide wing wall of asbestos board placed between the panel and the tank, at "W" in the sketch. Panel and tank had simply been located so close together—a bare 10 inches separating them at the nearest point—that the heat from the tank, radiating against the panel, raised the control to the tripping temperature.

The period of satisfactory operation immediately following the installation of the tank was explained by the calendar, as no difficulty was experienced during cool weather. The reason the trouble refused to show up while either the engineer or the electrician was standing by awaiting it, was that each had always seized the opportunity for a quiet smoke, leaving the pump-room door open and thus setting up enough air circulation to keep the relay cooled below the tripping point.

It was just another case of correct appliances appearing at fault when the true cause of the trouble was the effect of one on the other under operating conditions.

"And if you're real good, we'll let you use an I-R "Jackhamer" the last five years."

PORTABLE AIR-OPERATED SUMP PUMP

A NEW portable air-operated sump pump for general contractors, public-utility companies, mines, refineries, and other fields of service has been developed by Ingersoll-Rand Company, 11 Broadway, New York. It is an open impeller-type of centrifugal pump driven by a "multi-vane" air motor, both enclosed in a 1-piece housing. The unit weighs 50 pounds, and is designated as Sump Pump Size 25.

The pump will handle clear or dirty water, oil sewage, or moderately heavy sludge that have accumulated in sumps, trenches, manholes, caissons, cofferdams, tanks, bilges, etc.; and all parts are constructed of the best materials available for the particular service—bronze and rustproof and stainless steel being used where best suited.

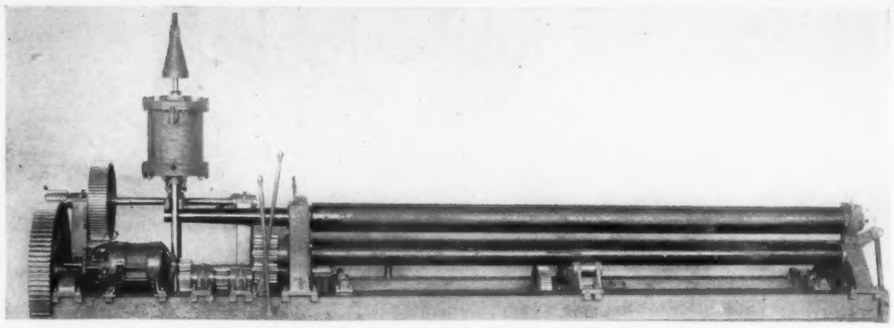
The pump is intended for lifts of from 10 to 40 feet with air at pressures of 70 to 80 pounds; but it is said to give satisfactory results under widely varying conditions of head and pressure. Using air at 80 pounds pressure, its capacity ranges from 170 gallons per minute with a 10-foot lift through 20 feet of 2½-inch hose to 125 gallons per minute with a 40-foot lift through 50 feet of 2½-inch hose. The new pump is self-priming, it has no suction lift, and must be submerged to cover the inlet screen.

Handy air-operated sump pump.

AIR CYLINDERS ARE FEATURE OF PLATE-BENDING ROLL

AIR AT a pressure of from 80 to 100 pounds per square inch serves to tip up and to knock down the upper roll of the newest type of heavy-duty horizontal plate-bending machine built by Wickes Brothers of Saginaw, Mich., for a Los Angeles concern. This use of compressed air represents a departure that makes for ease and speed of operation.

The air is taken from the regular shop line and acts upon pistons in horizontal cylinders, one at either end of the rolls. The cylinder for the knock-down is mounted on the floor, while that for the tip-up is mounted on top of the machine. The upper roll is 10 inches in diameter, but may be interchanged for one of 8¾ or 7¾ inches: the lower rolls are of standard 6-inch size. A dial recorder is provided that indicates the position of the top roll at all times.



Air cylinders, at opposite ends, tip up and knock down the top roll of this plate-bending machine. The connecting rod and a part of the knock-down cylinder are seen at the extreme right.

The main drive consists of a 15-hp. motor, and a 5-hp. motor operates the elevating device—the power being transmitted to the elevating screws through bevel gears. These, together with the pinions, are enclosed and immersed in oil. Lubricant is delivered to the various bearing points through a one-shot system. The bending roll is designed to handle mild-steel plates up to ¼ inch thick and 12 inches wide, and has a maximum capacity of 30 feet per minute.

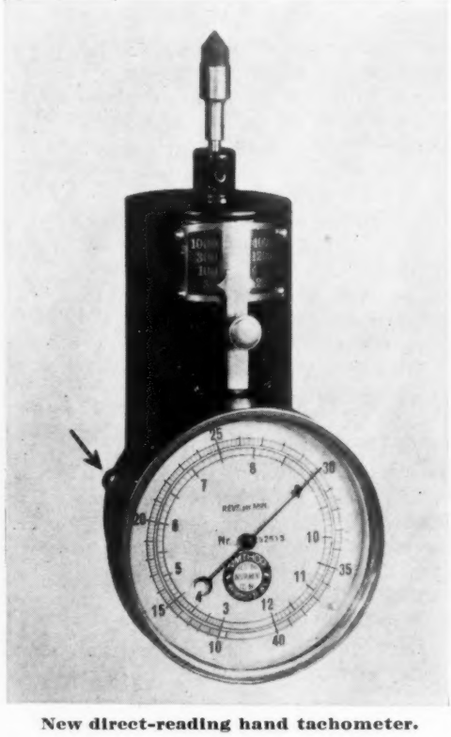
IMPROVED PAINT SPRAY CARRIES HEATING APPLIANCES

AT A RECENT joint meeting of the Association of Germany Chemists and the Association of German Engineers, in Berlin, there was introduced a new method and means for applying highly viscous paints having a linseed-oil or other heavy base. The spray gun is the invention of an engineer named Pahl, and differs from those now in common use in that the paint is fed to it in paste form. This paste, before it reaches the nozzle, is heated electrically, and is then ejected with compressed air at from 25 to 40 pounds pressure. Upon emerging from the nozzle, the atomized paint is again heated and this time with illuminating gas—the object being to hasten drying even under extremely humid conditions of the atmosphere and when the surfaces coated are moist. The temperature of the paint in the nozzle is around 300° F., while that of the fresh coat is something like 100° F. The gas required is drawn from flasks, and the electricity and the compressed air are supplied by a portable gasoline-driven outfit that has been especially provided for the purpose.

The outstanding advantages claimed by the inventor for this method of applying viscous paint are: Improved working conditions because of the absence of evaporating solvents and harmful fumes, and speed of drying after application. This depends, of course, upon the kind of paint used, but can be effected almost instantaneously.

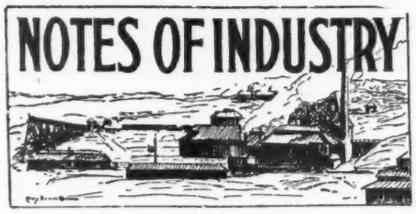
IMPROVED TACHOMETER

A NEW portable tachometer for recording machine speeds in revolutions per minute has been put out by Amthor Testing Instrument Company of Brooklyn, N. Y. The most important feature of the Type No. 350 is that it gives automatic, fixed reading. When applied to a rotating shaft, the hand instantly points to the speed and follows every pick-up and slow-down. When the instrument is removed, the hand does not return to zero, it remains fixed on the dial, thus obviating the need of keeping the eyes focused on the dial. For this reason the tachometer can be used in dark or in inaccessible places where it is impossible to hold and to see it at the same time. When again required, the instrument automatically resets itself. The dial reads directly in revolutions per minute; but by means of accessories all "feet-per-minute" cutting and surface speeds can be taken. It is equipped to give four speed ranges, each of which can be read separately throughout the entire circumference of the dial. The No. 350 facilitates the testing and checking of speeds of engines, blowers, compressors, shafts, etc., etc.



New direct-reading hand tachometer.

NOTES OF INDUSTRY



The use of electrically lighted house numbers is an innovation that should appeal to everybody.

Ball and roller bearings to the value of $47,829,000 were manufactured in the United States in 1931.

By reducing the thickness of its hot saws 1/16 inch, a steel plant in the Pittsburgh district has cut down the production of saw chips as much as 2,000 tons annually.

It is the practice in a western open-pit copper mine to spray the ore cars with salt water before loading in freezing weather to facilitate their dumping.

More than 5,000 tons of steel is consumed annually in the United States in the manufacture of miniature wind-up, electric, and steam-driven trains and tracks.

The filament of a 40-watt Mazda lamp is made of tungsten wire which is so thin that 32½ miles of it barely weighs a pound. Less than one-thousandth of an ounce of the filament is required for a lamp.

A stone native to each state in the Union has gone into the building of an arch at the approach to the Sky Line Drive in Canon City, Colo. The arch has been named the Gateway of the States.

Insulated wallboard is being marketed by the United States Gypsum Company under the name of "Insulating Sheetrock". It comes in sheets 3/8 inch thick and with one side metal surfaced.

Rubber-coated wire mesh for the making of baskets for use in electroplating baths is available. It comes in several grades of hard and pliable rubber and sizes of mesh. The rubber is bonded to the wire by a special process.

"Sekurit" is the trade name of a new, strong, non-reinforced glass that has appeared on the market in Germany. It is said to look like ordinary glass and to be highly elastic. When fractured, it crumbles into granular pieces without sharp edges.

According to the Bureau of Mines, the photographic industry of the United States is an important consumer of silver, in fact the second largest in the country. In 1931 it utilized 6,605,623 fine ounces, representing 27.9 per cent of the total consumption.

To prevent lacquer, paint, varnish, grease, oil, etc., from penetrating the pores of the skin and discoloring it, the DeVilbiss Company has put out a preparation or cream called Pro-Tek. When rubbed well into the hands before beginning work it forms a protective film that is soluble only in water.

Hercules Powder Company announces a new and improved permissible coal-shooting explosive known as Hercoal C-I. It is designed to supplant Hercoal C, to which it is reported to be superior as a lump producer and in point of economy. The new product has passed the permissibility tests of the United States Bureau of Mines.

Russia is now said to be producing more airplanes than any other country in the world. They are constructed of metal throughout and of an alloy, known as "alplato tsagi," recently developed there. The claim made for this alloy is that it has all the desirable qualities of duralumin but costs less to manufacture.

The proposed Pacific Highway from Blaine, Wash., to Fairbanks, Alaska, will cost $14,300,000, according to a member of the international highway commission. The road will open up the interior of Alaska to both Canada and the United States, and will make accessible 370,000,000 acres of land along its 2,225-mile course.

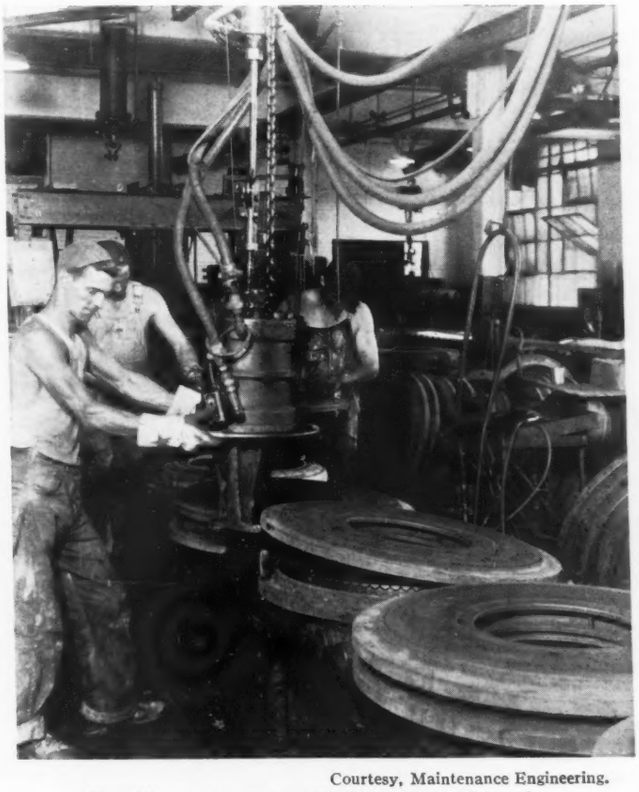
At a single stroke, and at the rate of one a minute, old automobiles that have been stripped of all non-metallic materials are converted into bales of scrap each 6 feet long, 30 inches wide, and 18 inches deep. The giant hydraulic press that does this has been recently installed in the Rouge plant of the Ford Motor Company.

From Japan comes the report of the discovery of a new magnetic alloy composed of nickel, steel, and aluminum. It is said to possess twice the magnetic properties of K. S. steel, which also was developed in that country and which was believed to be the most magnetic of all the metals and alloys. Further claims made for the new alloy are that it costs one-fifth as much as K. S. steel, weighs 20 per cent less, and is more durable.

It is a well-known fact that forming dies plated with chromium last longer than dies not so plated; but that a thin coat may be better than a thick coat was something for the United States Mint at Philadelphia to determine. The experience in that Government plant has been that heavily plated dies, used in stamping nickel coins, gave unsatisfactory results, whereas a thinner coating, one of 0.0002, not only increased the life of the dies considerably but also improved the quality of the coins.

Arrangements have been made whereby Ingersoll-Rand Company, 11 Broadway, New York, has acquired exclusive rights to market SKF drill steel throughout the world. The product is being sold under the trade name IR-SKF. This brand of steel, which is claimed to be of unusually high quality, was developed as a result of exhaustive tests and experiments by the technical departments of Ingersoll-Rand Company in collaboration with the SKF mills.

The high power and fast speeds of modern rock drills call for a high-quality drill steel with long-fatigue life to resist breakage and to give fast cutting power. It is said that IR-SKF steel meets these requirements; that it is easy to shape and sharpen; and that it will hold its cutting edge and gauge through a long period of service. IR-SKF steel is available for immediate delivery in all standard sizes and sections in both solid and hollow forms. The hollow steel is made by the SKF "supersmooth" hole process, which is claimed to produce an absolutely uniform hole throughout the length of the steel.



Courtesy, Maintenance Engineering.

Breaking open tire molds by the use of an air-operated device designed by the plant engineer of the India Tire & Rubber Company. The contrivance is controlled by a push button.

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